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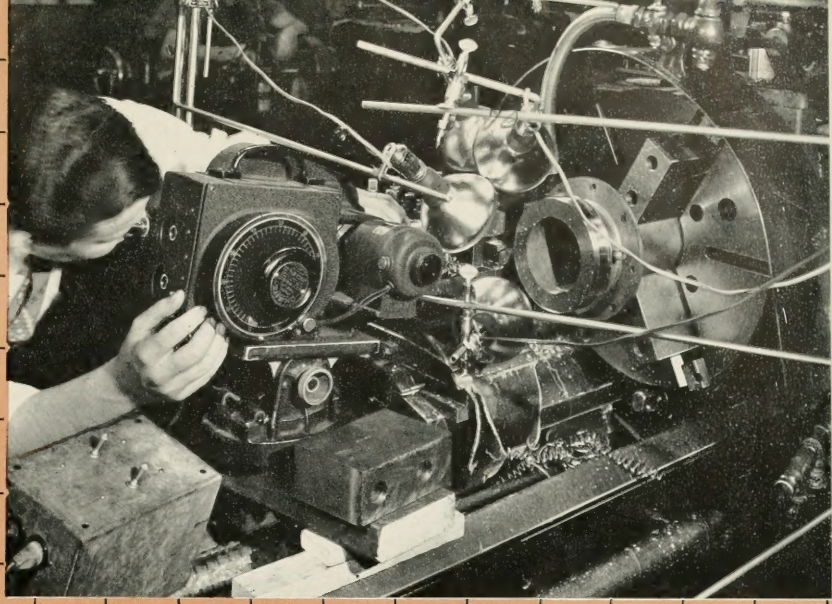

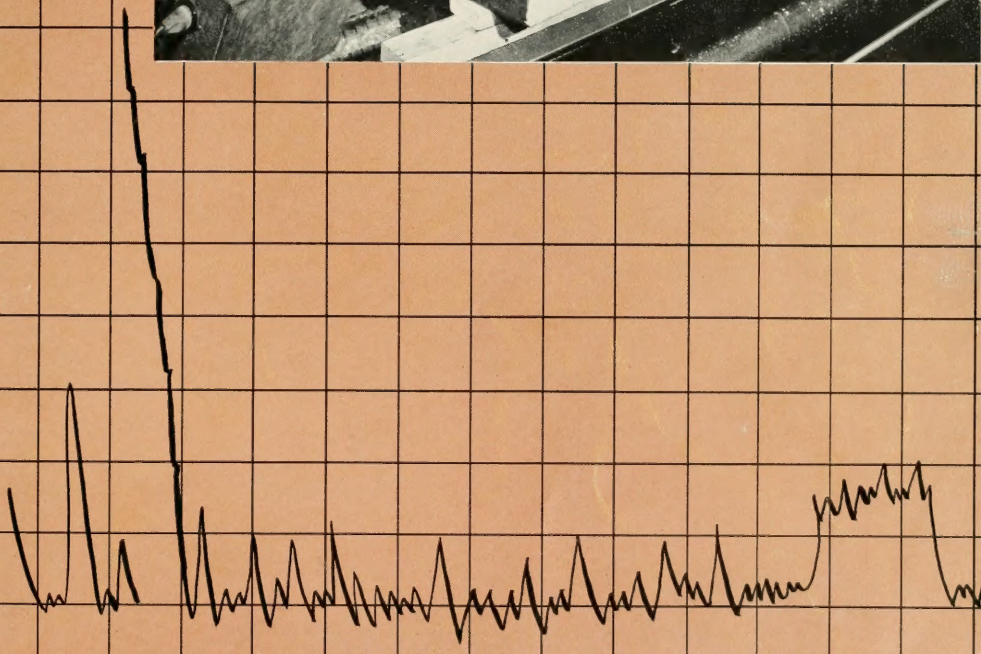

the **illinois technograph**

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october, 1951

Another page for **YOUR BEARING NOTEBOOK**

It's a cinch for a winch on TIMKEN® bearings

Heavy loads and wear are the problems engineers have to face when they design earth moving equipment like this. To carry the load on the winch, ten Timken® bearings are used. Thirteen more on the differential, pinion shafts, jackshaft drive wheels and rear wheels assure long life and trouble-free performance. Timken tapered roller bearings take any combination of radial and thrust loads, reduce friction, permit tighter closures. And they normally last the life of the equipment.

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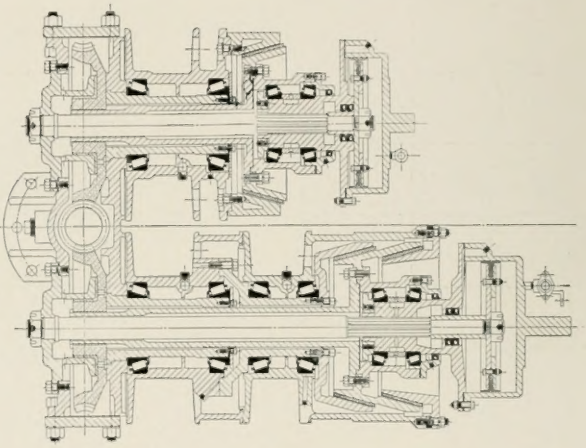
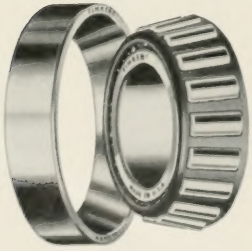
To provide rigidity for both the single and double drums, the Timken bearings are mounted cone-adjusted. The adjustment is obtained through the use of shims between the members carrying the Timken bearing cones and the units bolted to these members. A cup-adjusted mounting is used in the units carrying the clutch housing. In this case, the adjustment of the Timken bearings is obtained with shims between the cup carrier and the housing.





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Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For additional information about Timken bearings and how engineers use them write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

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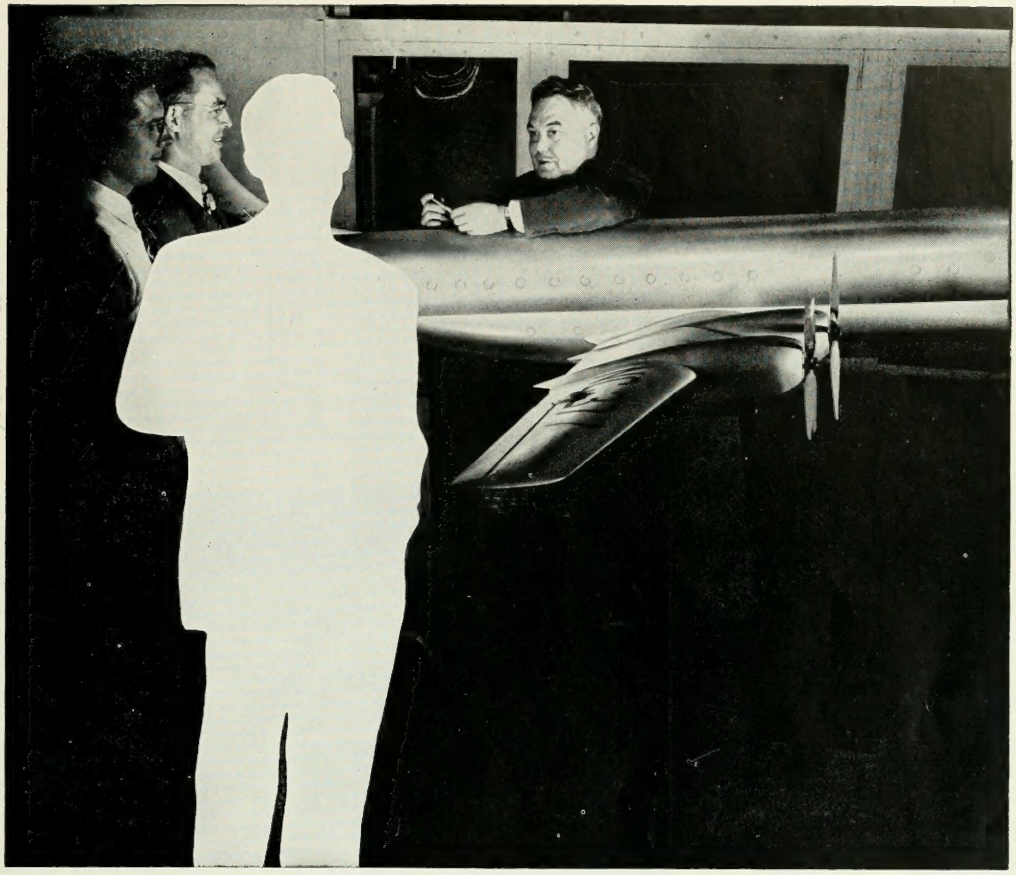

Do you fit in the Boeing picture?

Boeing's world-wide reputation for sound engineering achievement is founded on *men*. Boeing engineers and physicists are graduates of many universities and technical schools. They come from every state in the Union. Under inspiring leadership they have been welded into one of the most potent forces in any field of scientific advance.

If you can measure up to Boeing standards, there is an attractive future for you in this renowned group. In addition to the prestige which attaches to being a member of the Boeing engineering team, there are other definite advantages:

1 The challenge of working on such vital programs as the B-47 and B-52 jet bombers, guided missiles and other revolutionary developments.

2 Stability of career opportunity with an engineering division that is still growing steadily after 35 years.

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4 Good salaries. And they grow with you.

5 Moving and travel expense allowance.

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Boeing's immediate needs call for experienced and junior aeronautical, mechanical, electrical, electronics, civil, acoustical and weights engineers for design and research; for servo-mechanism designers and analysts; and for physicists and mathematicians with advanced degrees.

Write today to:

JOHN C. SANDERS, Staff Engineer—Personnel
Boeing Airplane Company, Seattle 14, Wash.

BOEING

skimming industrial headlines

edited by Bob Hardin, e.e. '54

visual screens for aircraft

Pilots of future supersonic aircraft may watch a screen like the one pictured to know what is ahead of them and their relation to the horizon. This screen, with an optical system to project an image from ahead of the plane on it, was installed in a University of Illinois aircraft by Dr. Stanley N. Roscoe, University psychologist, for tests of how well pilots could fly with such a screen. He found they could fly very well.

The information will allow future high-speed craft to provide such a picture through television or a periscope from the front of the airplane, and to eliminate the friction-producing projecting windshield. Dr. Roscoe made tests with screens ranging from the 8-*in.* square shown, down to a 2-*in.* square. Shown on the screen are runways of the University of Illinois Airport as the airplane approaches it.

improved mine detector

An improved mine detector developed by the Corps of Engineers which will operate on land and under water should prove more effective in locating mined areas and expedite the movement of ground troops.

The new detectors will locate buried mines in any kind of soil, according to the Army. Older types are useless where magnetite or black earth is prevalent. The Army says the new detector, also able to operate under water, should prove more effective in clearing beach areas. It has been a practice to lay land mines in shallow water near beaches to intercept landing craft and troops.

The presence of a buried mine is indicated to the operator of the new and improved device by a combination of visual and auditory means. The visual meter indicates the presence of a mine, and, simultaneously, its presence is further revealed by a distinct sound in the headset worn by the operator.

new optics

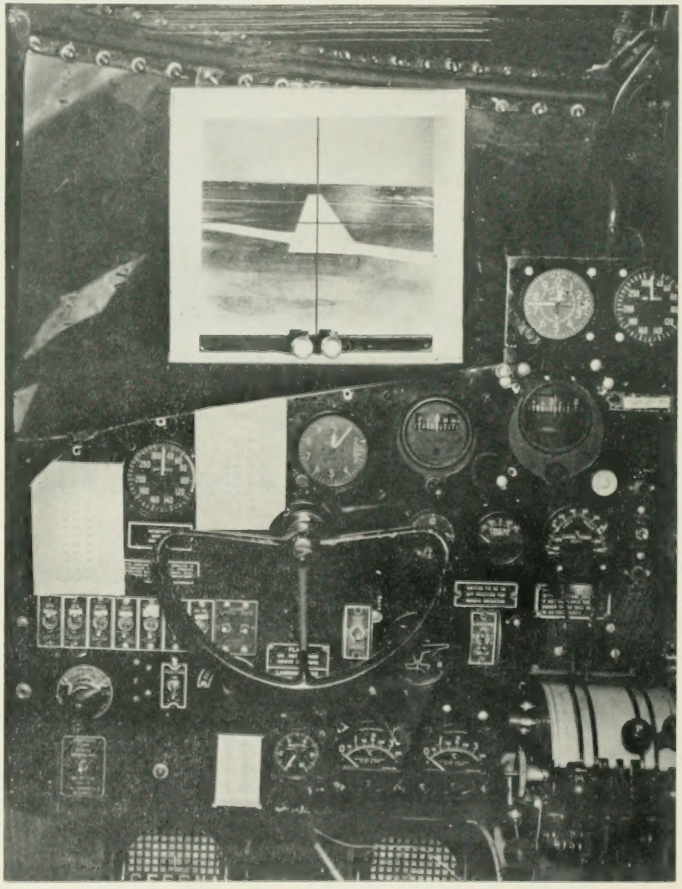
One of the most difficult jobs in the history of optical manufacture has been completed by Bausch & Lomb Optical Company for the Vatican Observatory.

The task involved production of four identical six-inch prisms, special lenses and first-surface mirrors for a spectrograph for the Vatican's Astro-Physics Laboratory that will determine the composition of stars of various magnitudes.

Made from a flint-type glass, specially selected and highly annealed, the 61-degree prisms are accurate in performance to five millionths of an inch and required nearly two years to produce. Interferometer tests, the most precise known, were used to determine the extent of each polishing operation. Fine polishing, which is done by hand, was limited to ten minutes so that heat generated by polishing did not damage the prisms. After each operation, the prisms were allowed to cool off for one hour.

The spectrograph will be used with a telescope to record light emanations of stars on sensitized photographic plates. Through its prisms, it will split light into its component colors or wavelengths, and by reference to these, the

(Continued on Page 32)



Pilots of the future may do their flying with the aid of visual screens such as the one shown here lined up on the U. of I. airport.

a word of advice...

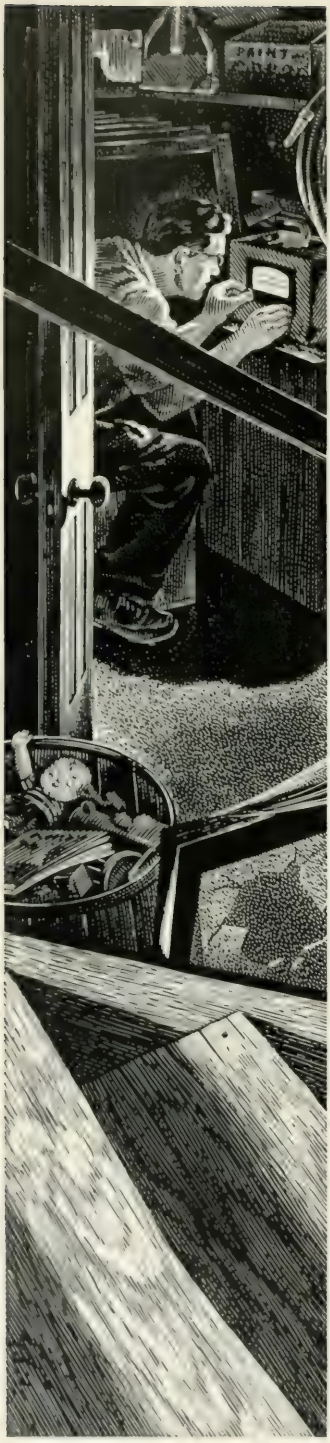
It is usually customary at this time of the year for the editor to extend a welcome to the new freshmen. This editorial, however, will deviate somewhat from tradition in that it is not intended to be a welcome.

When a person first enters college, he is faced with two main problems: (1) how much time must he allot for his studies? (2) how much time can he allot for extracurricular activities? Obviously, there is no set rule which can apply to all students. It is up to the individual himself to determine his capabilities.

There is one point, however, that needs emphasizing. Don't be too eager at first. Frequently, new students will join an organization, take on responsibility, and then find that because of poor scholastic work, they have to pass on their responsibility to someone else.

Organized houses, in particular fraternities and sororities, are often guilty of over-emphasis of activities. Certain individuals feel that it is necessary to uphold the prestige of the house by encouraging students to participate in as many activities as they possibly can. Unfortunately, students occasionally join organizations in which they have no real interest. Consequently, they are wasting their time and the time of the organization as well. There is no fault in organized houses trying to encourage activities, but it must be done skillfully and with regard to the student's own liking.

You must strive for a balance between your studies and your activities. If the question should arise as to which is more important, remember — your primary reason for being in college, in spite of what some may think, is to study.—H.P.K.



The Hidden Radio

"It was spooky down in the cellar.

"The wife had taken over the upstairs radio for her pet soap opera. And the kids had their eyes glued to the western on the TV. So I had to dig up the old portable, hidden away in the basement storeroom.

"When the newscast was over, I clicked off the set and just sat there, thinking about other men in cellars of communist-dominated countries. Men listening at the risk of their lives to broadcasts from beyond the Iron Curtain. To words of Freedom.

"The Great *Red* Father doesn't like hidden radios! I don't wonder he cracks down, because Freedom and dictatorship don't mix. *We* took hold of our Freedoms back in 1776 and, through wars and depressions, we've hung onto them mighty hard.

"Those Freedoms are all in our Bill of Rights, and the chances of any *outside* enemies taking them away from us seem pretty slim to me. But we musn't forget the enemies *inside* our boundaries, too. The religious and race hate-makers . . . the pint-size dictators . . . the wild-eyed reds and the slimy parlor pinks. The woods are full of 'em!

"And if we aim to keep our Freedom of religion and speech and press . . . if we want to keep our jobs safe, like mine down at the Republic mill, helping produce important steel . . . then we've got to keep our eyes and ears wide open to spot these *inside* enemies. They might be miles away . . . or living within our own community.

"In other words, we must keep informed about what's going on today. That's why I didn't want to miss the newscast . . . even if I had to risk my rheumatics in that dark, damp cellar."

REPUBLIC STEEL

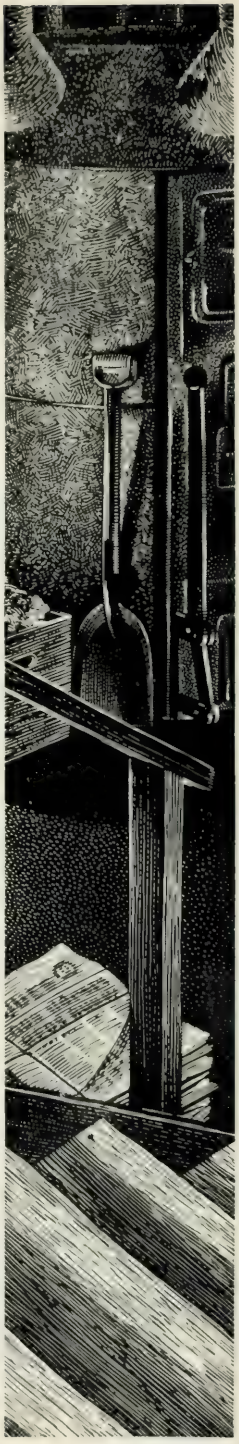
Republic Building, Cleveland 1, Ohio

REPUBLIC STEEL

Republic BECAME strong in a strong and free America. Republic can REMAIN strong only in an America that remains strong and free . . . an America that has built its many industries from infancy to world leadership. *And through all industries Republic serves America.* The Communications Industry is a case in point . . . with its millions of telephones, its miles of telegraph and cable wires, its countless radios and TV sets. Much of the steel used in such equipment . . . carbon, alloy and stainless . . . comes from the many far-flung furnaces of Republic, which is proud to be a part of the voice of America at home and abroad.

* * *

For a full color reprint of this advertisement, write Dept. H, Republic Steel, Cleveland 1, Ohio



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the illinois technograph

volume 67 number 1

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our cover

This perplexing and rather confused tangle of lights, wires, camera, timer, and machinery illustrates the role that photography is playing in engineering work today.

our frontispiece

Laboratory icicles: in the 20-below-zero temperature of this refrigerated "igloo," a circuit breaker is being prepared for a high voltage test.

scientists are now fighting a . . .

cold war

by Hank Kalapaca, e.ph. '52

The coldest temperature ever recorded on the earth's surface due to Nature's handiwork was 90° F below zero. This record was set on February, 1892, in the northern Siberian village of Verkhoyansk. If someone tried to tell a low temperature physicist that 90°F below zero was cold, he'd probably scoff at him and say, "Cold—that's hot!"

Actually, the physicist would have good reason for making such a statement for his work takes him down to temperatures around –273°C (about –460°F)—just a hair's breadth from absolute zero!

Today, it is not uncommon to read an article in a magazine or newspaper about experiments being conducted to investigate the properties of matter at very low temperatures. However, such was not the case a few decades ago. It is not that scientists didn't realize the importance of such experiments, but the technical difficulties confronting them in trying to obtain and maintain very low temperatures were staggering. One not only had to be a physicist—he had to be a refrigeration engineer, too.

Most of the pioneering in the field of low temperatures took place in Europe and England. Unfortunately, it took a war to finally get the United States interested in this field. Prior to 1946, there were only two laboratories here engaged in low temperature research. Now, however, the situation has changed radically. There are low temperature laboratories all over the United States. Most of the work is being sponsored by the Office of Naval Research and the National Bureau of Standards. General Electric, however, has recently built a 250,000 dollar laboratory and there are universities extending from the Massachusetts Institute of Technology to the University of California which are also very active in this field.

There are two main reasons for this rapid development. First of all, the development of new methods of liquefaction, as a result of work undertaken for military purposes, has made the production of liquid helium no longer a major undertaking, but a relatively easy task. The other reason for the increasing interest in very low temperatures is probably due to the challenge presented by the problems which still stubbornly refuse to yield to theoretical explanation.

HANK KALAPACA

In this issue, even the editor worked. In addition to his duties on the TECH, he is a member of Phi Eta Sigma, Sigma Tau, and Air Force ROTC.

A senior in engineering physics, his hobby is hypnotism, which may explain how he continues with his activities, maintains an excellent scholastic average, and makes the TECH staff work at the same time.

One word that is heard quite frequently around low temperature laboratories is cryogenic—the first part of the word is from early Greek and means cold. Consequently, laboratories engaged in studies in the extremely low temperature range are known as cryogenic laboratories.

Concept of Temperature

Before any attempt is made to explain how very low temperatures are obtained or how they are measured, the concept of temperature has to be clearly defined.

To the man in the street, temperature is something he feels by his sense of touch. When he touches a hot object he says that the temperature is high, and that's about all he can say about it. Actually, he is witnessing the transfer of energy from the molecules of the substance to his skin. This transfer of energy could also be obtained from the radiant energy of the sun, a sun-lamp, a stove or radiator, or just from the walls of a room.

To a physics student, however, the concept of temperature would probably have a different meaning. He is accustomed to thinking of temperature as

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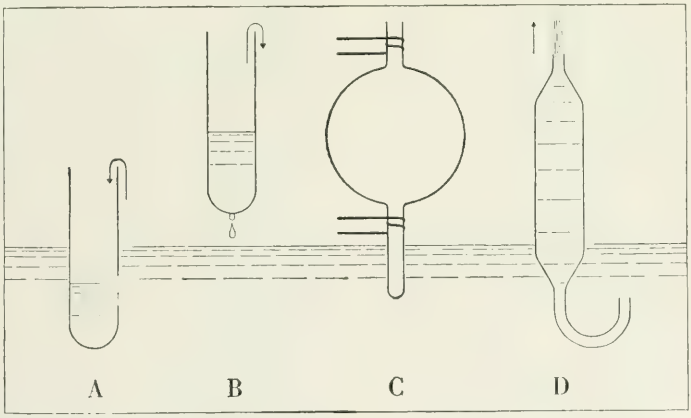

Liquid helium behaves strangely when it is cooled to 2.19°K. If a vessel is lowered into (A), the helium climbs in. If the vessel is lifted out of it (B), the helium climbs out. The speed with which this film travels may be measured by timing its arrival at the top wire on a glass bulb (C). If helium is allowed to enter a fine tube at the bottom of another vessel (D), it will spurt from the tube at the top when light is shined on it.

Architects find that color slides of buildings and models often illustrate styles and methods of construction better than more bulky models.

chanical engineers may start collecting slides of installations and equipment in their field of specialization that will prove invaluable in future design and research problems. Architects find that color slides of buildings and models often illustrate styles and methods of construction better than more bulky models. These and many more uses of color slides are in the possession of the photographer.

Movies for use within the organization by which they are filmed can often be made by the amateur cinematographer, using his own equipment. For films made for public showing, the professional touch of specialists usually enhances their sales value. For the engineer who wishes to present the unusual, there is the color-separation Anaglyph system of three dimensional motion pictures using standard projectors and screens. Although this process is not well known, and not the height of practicality, it is capable of producing unusual effects and adding realism to difficult subjects.

Everyone remembers the childhood

photography in engineering

by Henry Spies, ag.e. '52

"Amateur photographers are just frustrated chemists." This statement, undoubtedly made by a jealous chem. engineer, is often heard when the cache of equipment that the serious amateur possesses is unearthed. This article is to help picture-snapping engineers justify their avocation on a basis other than psychological satisfaction.

One of the most widely known jobs of the engineer-photographer is in the field of visual education. The most popular forms of visual education are the color slide and the motion picture. These media are most useful to the engineer because the usual projection equipment is much easier to transport than would-be models and demonstration equipment. The old adage that a picture is worth a thousand words was never more truer than in the field of engineering.

A simple photograph or slide will show a wealth of detail that defies verbal or written description. The role of the motion picture is even more important due to its versatility in showing a complete process with full scale operations, in color or monochrome, to an audience almost anywhere. With the special effects available in cinematography, it has rapidly become one of the most popular salesmen and demonstrators in the field of engineering.

HENRY SPIES

For his first feature article, Hank has chosen to write about a subject that he himself knows quite a bit about from actual experience. Photography has been his major hobby for the past five years.

In this article, he points out several uses of photography in engineering that the average camerist might utilize.

Besides having worked on the TECH for a year, Hank is in the advanced AFROTC and is a member of ASAE and ASCE.

Color slides are within the scope of nearly any camerist using his present equipment, or with a few additional items. This technique is readily adapted to almost any type of subject material and equipment available. Civil and mechanical engineers may start collecting slides of installations and equipment in their field of specialization that will prove invaluable in future design and research problems. Architects find that color slides of buildings and models often illustrate styles and methods of construction better than more bulky models. These and many more uses of color slides are in the possession of the photographer.

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Everyone remembers the childhood game where a simple whispered statement is relayed from one person to another with a humorous distortion as the end result. This might be fun at a party, but errors in duplication are not the least bit humorous in the engineering world. When there is a need for a copy of a document such as a report, a contract, a letter, or an engineering drawing, the need is not for an approximation; the need is for an exact copy. Photocopying is the fastest, easiest, and most accurate method of documentary reproduction.

In the same category as photocopying is microfilming, a process used for reproduction in any size other than the original size to facilitate filing of large drawings and documents. The main difference between photocopying and microfilming is that no intermediate step between the original and the copy is necessary in photocopying.

Both of these processes can be easily performed by the amateur photographer. In photocopying, all that is necessary is a contact printer of sufficient size,

high contrast positive paper, and proper processing chemicals and facilities. Microfilming is more efficiently done with the special equipment designed for the purpose, but it can be done with most 35*mm.* cameras that can be equipped with extension tubes or closeup lenses with few additions to the camerist's usual equipment. Larger size copy negatives may also be made with cameras which have ground glass viewfinders and double-extension bellows.

Just what happens when a force is applied to a rigid member of a machine or structure has always been of necessary interest to engineers. Both safety and economic considerations dictate this interest. Again, photography speeds up investigation and makes a normally complex task an easy one.

Perhaps the easiest method of determining stress distribution in a machine or structural section is to construct a clear plastic model of the section in question, load it exactly as the prototype is to be loaded, and illuminate it with polarized light. The result is a spectacular illustration of the stress distribution.

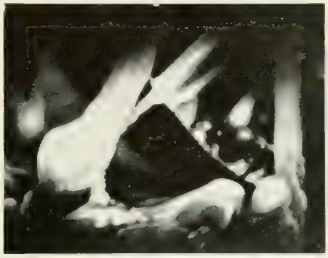
The stress patterns brought out by the polarized light may then be photographed in monochrome or color for a permanent record for use in design and in classroom discussion. The engineering camerist can perform this service with no more than the usual complement of equipment and facilities, although exposures may have to be determined by the trial and error method. If these stress patterns are photographed in color, the exposure must be made reasonably within the exposure for which the particular type of color film is balanced, or serious errors in color rendition are quite probable.

Other methods of stress analysis that employ photographic recordings include those using oscilligraphs, the Wheatstone bridge, and the mirror galvanometer.

One of the most widespread uses of functional photography in engineering is in the field of instrument recording. The accuracy of photographic recordings is unquestionable. It provides an enduring account of conditions at the desired precise instant with no possibility of erroneous readings of transient variables. With photographic methods, the human element is eliminated as is time-consuming checking and rechecking. The types of instruments which can be made to record photographically are almost unlimited.

Have you ever had a lab instructor doubt your data, insisting that it is impossible and perhaps implying that he thinks you dry-labbed the whole experiment? A simple photograph of your equipment and instruments when you observe inexplicable phenomena is definite proof of your ability and integrity.

Many electrical engineering and physics courses use oscilloscopes extensively in laboratory work. Can you describe adequately what you saw in class when writing your lab report? Photographic oscillograms need little explanation. The technique for obtaining useful oscillograms with the minimum of equipment is as follows: place the camera on a solid support, with the field of view including the face of the oscilloscope, feed into the instrument a wave of known shape and magnitude, and photograph it. The grid face of the oscilloscope is then removed, and the results of the experiment which appear on the face of the tube are photographed. When the prints are to be made, construct a grid



The result: the molten metal is caught in action.

on the top of the enlarging easel, using thread or similar material. The easel and enlarger are set so that the grid on the easel corresponds to the grid on the oscilloscope through the use of the negative of the known wave. The enlarger and easel are then locked in this position, and the rest of the negatives are printed with perfect correlation with what actually appeared on the oscilloscope. The use of high-contrast film and paper is recommended, although much the same result can be obtained through overdevelopment.

This particular case was cited as an example of the multitudinous uses in the field of instrument recording that are within the reach of the amateur who exercises his ingenuity.

A development that has become increasingly important in the field of engineering during recent years is the use of spectrography in the analysis of materials. Once, such studies could be made only by lengthy laboratory techniques; but by applying photography to the problem, more graphic and more easily understood data can now be obtained, and a permanent record made of them at the same time.

If the material whose composition is in doubt is burned in an arc, and the light given off directed through a ruled grid, lines will appear on a spectrum scale, characteristic of every element in the original material. When a photographic emulsion is exposed to these line images, a permanent record is obtained capable of showing even minute traces

(Continued on Page 26)

A special high speed camera records the complete welding operation of an electric arc which can later be analyzed.

U. of I. research

The University of Illinois has long been noted as one of the outstanding engineering schools of the country, not only for its program of undergraduate training, but also for its graduate work and for the vast amount of research that is being conducted in the different engineering departments.

Many of the major research problems being investigated at the University have been so largely publicized, they have become relatively familiar to most Tech *readers. There are numerous programs, however, that are equally important, but are less known.*

This article covers a few of these lesser known phases of research.

•

Light Flicker Research

If electric welding machines of the most popular type are causing your lights to flicker, University of Illinois engineers now know what to do about it. The data on this problem which power companies have until now been able to attack only by guess was prepared by Marvin Fisher Jr., Prof. Stanley Helm, and Prof. Max A. Faucett. They claim that electric motor loads as far as five miles away have important bearing on the effect of single-phase welders on three-phase power lines.

The University of Illinois Engineering Experiment Station has prepared a bulletin with tables from which power engineers can quickly compute the size of wires and amount of current needed to prevent objectionable flicker.

The solution was worked out in a cooperative research project of the University and the Utilities Research Commission of Chicago. The Illinois engineers worked for two years, using a mathematical and analytical approach, to solve the problem and prepare the simplified tables.

Now, they are tackling a tougher problem—three-phase welders which are becoming increasingly popular, but which with vacuum tubes in their circuits are much more complicated devices to analyze.

Lead Cable Research

Arsenic, though deadly to humans, can give longer, stronger life to underground electric cables, according to research at the Engineering Experiment Station of the University of Illinois. The idea is being adopted wholeheartedly by the electrical cable and power industries.

This is the latest finding in a 21-year project which already has brought a $100,000 a year benefit to its sponsoring agency and saved hundreds of thousands of dollars more for the whole power industry.

That amount yearly is saved by one fact alone—reported in 1935—that a copper-lead alloy for covering cables is just as satisfactory as tin-lead alloy which costs 10 per cent more.

The latest finding is that the lead for covering cables can be improved by adding a "pinch"—one-tenth of one per cent—of arsenic. This will make cables longer-lasting and allow them to carry heavier electrical loads because higher pressure can be used for the insulating oil inside the cable.

Lead cable sheaths are being studied in Arthur Newell Talbot laboratory at the University of Illinois by Prof. Curtis W. Dollins. At this moment he has 141 different specimens under test.

The University's Engineering Experiment Station has just published the sixth report from his work. It contains the findings on benefits from arsenic in the alloy. The work has not only produced direct results such as this, but also by stimulating research of cable manufacturers has brought valuable indirect results.

The project at the University started in 1929. It is sponsored by the Commonwealth Edison company of Chicago through the Utilities Research commission. In the 21 years, this has provided nearly $115,000 for the work. The one fact about tin-lead alloy saves annually nearly all that was spent in the first 20 years.

The 141 tests Professor Dollins has going on now include: two full-size cable specimens nearly a yard long being bent back and forth every 6 minutes; 19 sections of cable being given time tests with oil inside them at 25 to 40

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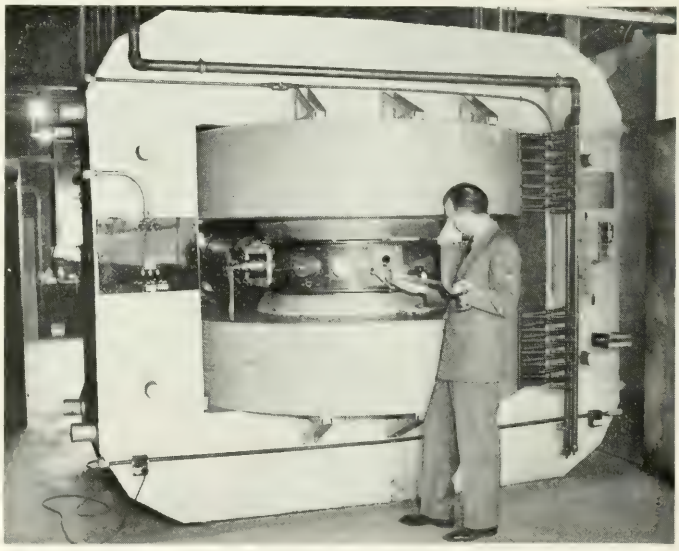


Extensive use has been made of the U. of I. cyclotron in the field of nuclear physics.

chi epsilon themes

edited by Paul Hutchinson, mining e. '54

As one of their pledge duties, prospective members of Chi Epsilon are required to write a short theme on some phase of civil engineering. For the benefit of this year's pledges, the Technograph is publishing three of the themes which were submitted last semester.

"Small Town Sewage Disposal" was written by Bob Kell, "Foundation Problems in Mexico City" by Jim Tavares, and "Prictical Civil Engineering" by Jeff Newton.

Small Town Sewage Disposal

Today in our fast moving world of chaos, one of our most perplexing problems encountered is that of small town sanitation. In Illinois alone there are numerous towns containing a population of 1500 or less, many of which contain no sanitary disposal system of any kind. This is alarming when we consider the fact that it affects the health of thousands of people, economic standards, and living conditions.

This problem has become apparent to many small towns and they have begun to study solutions to it. Just such a town is that of Norris City, Illinois, located in the eastern part of Southern Illinois near Carmi. Their need became apparent in the 1930's and they began planning and constructing a sanitary system as a PWA project in 1940 and 1941. However, before any great amount of work could be completed, PWA was abandoned due to World War II and the project could not be completed.

Early in 1949, with new officials in the city's government, it was decided to finish the project. Stockpiles of existing materials were inventoried and inspected for possible use in the finished project. Other details were attended to in rapid order so that by the latter part of 1949 the project was ready for the contractors to submit bids.

Early in June, 1950, the contractor began moving his equipment into the city. Existing sewers and manholes were located and cleaned out. Lines and grades were located by the engineer and pipe was scattered. The company's ditching machine was put into operation and pipe was laid as close to the machine as possible.

As the operation got under way, men located utilities and other obstructions ahead of the ditching machine where they were cut and replaced immediately after the machine had passed. Tile layers were protected from cave-ins by skeleton shoring which was removed after the tile was layed. Ditches were immediately backfilled with a small highlift and the street was again opened to traffic.

As the work progressed on the laying of sewer pipe, another force of men were busy at the disposal plant site. A partially completed tank was pumped dry and cleaned up in preparation for its completion. A water line was moved out of the site area without disrupting service for any length of time. Carpenters began building formwork to complete the first tank. Two ready mix concrete bins were placed and stockpiles of sand, gravel, and cement were placed in position for use at any time with a full day's requirements on hand at all times. A crane was brought in to dig the additional tanks and the work was scheduled with a view of keeping all men and equipment busy without any delay or layoffs. Concrete was poured just as soon as formwork permitted.

After the completion of the first tank, the carpenters began setting plywood forms for the construction of a 17 *ft* square control building which proved to be a most difficult construction problem, for in digging the basement of this building there appeared a stream of water of considerable size to be combatted during construction. The problem was finally solved by placing 8 to 10 *in* of gravel over the basement floor and installing a sump pump to remove the water until construction had been completed. This solution worked comparatively well for this structure. However, later on, in building a round shaped tank with a cone shaped bottom, the same streams of water was encountered at a lower depth in the cone shaped bottom. This indeed, formed a problem, for equipment was not available to the contractor for placing concrete behind the cone shaped form without excessive cost which necessitated placing the concrete bottom somewhat as a plasterer would place plastering using a vry dry mix of concrete. Water, however, complicated this procedure in that the dry mix mould absord so much water from the stream that it would slump down the sides before the concrete had a chance to set up. As a solution, it was finally suggested that the water be directed through covered channels to pipe running through the concrete to a barrel where a sump pump would remove it. The bottom was then placed as originally planned.

As this is being written, the project is still under construction. Because of unusually bad weather conditions during the construction, the project is not likely to be completed until next year's construction season. However, when it is completed, it will adequately serve the Norris City, and will improve the city in many ways.

Foundation Problems in Mexico City

Mexico City, a city of two million people, presents a good example of the difficulties encountered in constructing buildings on undependable foundation material. This city with buildings thirty stories high has been built on soft clays formed of volcanic ash that have a water content up to 500 per cent. Buildings settle many feet below the surface, or if they are on long piles, they seem to rise several feet since the surrounding ground settles as water is drained from it. These difficulties have

(Continued on Page 26)

introducing . . .

by Howard Hadler, ag.e. '54
George Ratz, c.e. '52
Tom Madden, e.ph. '54

PROF. JOHN M. COAN

Professor Coan was born in Baltimore, Maryland, on April 28, 1915. He became interested in engineering during his latter years in elementary school while observing the outside work of surveyors and construction engineers. He then went to the Baltimore Polytechnic Institute—probably the finest technical high school in the United States. This was a school attended by 3000 boys and offered courses in calculus, strength of materials, graphic statics, and thermodynamics along with the shop courses and other secondary school courses. This exceptional start enabled Prof. Coan to skip the freshman year of college and familiarized him with all subjects in the sophomore year.

From 1932 to 1938, Coan attended Johns Hopkins University where he received his B.S. Degree in civil engineering and the M.E. (M.S.) Degree, majoring in structures. Coan resumed his graduate training in 1946 at the Polytechnic Institute of Brooklyn where he received his Ph.D. in aeronautical engineering in 1948.

Prior to the resumption of his graduate work, Professor Coan worked as a stress analyst at the Glenn L. Martin Aircraft company in Baltimore from 1938 until 1942. As assistant professor of aeronautical engineering at Iowa State College from 1942 to 1946, he taught a wide range of aeronautical subjects to both civilian and military students. Coan then took an interim summer position as structures test engineer at the Douglas Aircraft corporation, Santa Monica, California, where he worked on both static and component tests. As research associate at the Polytechnic Institute of Brooklyn during the following year, he supervised a Navy-sponsored test program on fiberglass plates.

PROF. JOHN M. COAN

Professor Coan was appointed associate professor of aeronautical engineering at the University of Illinois in 1948 and promoted to full professorship in 1950. At this university he has been teaching aircraft structures, structural design, structures laboratory, and related courses—at both the graduate and undergraduate levels. He has been the faculty adviser to the student chapter of IAS for the past two years, and is the department representative on the Policy and Development Commission of the engineering college.

By his own admission, Coan is a "bookish" fellow, but he finds time, as most of us, to "play at" golf. However, most of his spare time is devoted to concerts, lectures, and extensive reading in non-technical fields such as international affairs, philosophy of education, psychology, music, art, and history. He is particularly interested in traveling in Europe where he has spent two 3-month vacations in the past 13 years. The present trend of the aviation world into the romantic areas of jet propulsion and supersonic aerodynamics has not lured the professor away from his field in the analysis and design of aircraft structures.

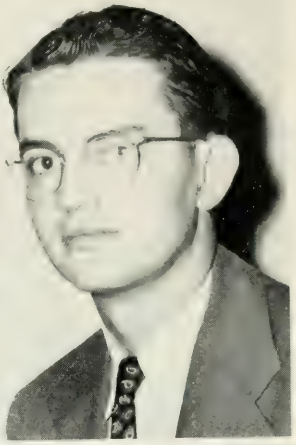
From Coan's students, the writer has learned that the professor's courses are handled in an excellent manner. However, he has never been proud of his punctuality. Perhaps this can be explained by the fact that he is a bachelor.

Coan is a member of Tau Beta Pi, Sigma Xi, the Institute of Aeronautical Sciences, the Society for Experimental Stress Analysis, the American Society for Engineering Education, and the American Association of University Professors.

DR. CHARLES P. SLICHTER

Many authorities agree that the first step toward a successful career in teaching is to gain the confidence of one's students. This being the case, Dr. C. P. Slichter of the physics department has certainly started off on the right foot, for he has been voted the most efficient instructor in that department. The most efficient instructor poll was held last May, juniors and seniors being the only students eligible to vote. To be recognized by this poll is in itself quite an honor, but to gain this recognition during one's first year of teaching upperclassmen, as Dr. Slichter did, is indeed worthy of high merit.

Although he was born in Ithaca, New York, Dr. Slichter calls Cambridge, Massachusetts, his home, as it was there that he spent most of his life before coming to Champaign-Urbana. A quick look at Dr. Slichter's ancestry leaves little doubt as to what his life's work should be. The son of a Harvard professor, his two grandfathers were also professors; one served in the civil engineering department here at Illinois, and the other was the dean of Wisconsin's graduate school. As if this were not enough, two of his uncles are professors at the University of California and Cambridge University.



DR. CHARLES P. SLICHTER

In 1941, Dr. Slichter entered Harvard with the class of '45 as a physics major. At Harvard, physics majors receive a great amount of electronics in their first two years. Because of this, a group of them were called during their junior year by the NDRC (National Defense Research Committee) to Woods Hole, Massachusetts, for work on a highly secret underwater explosives

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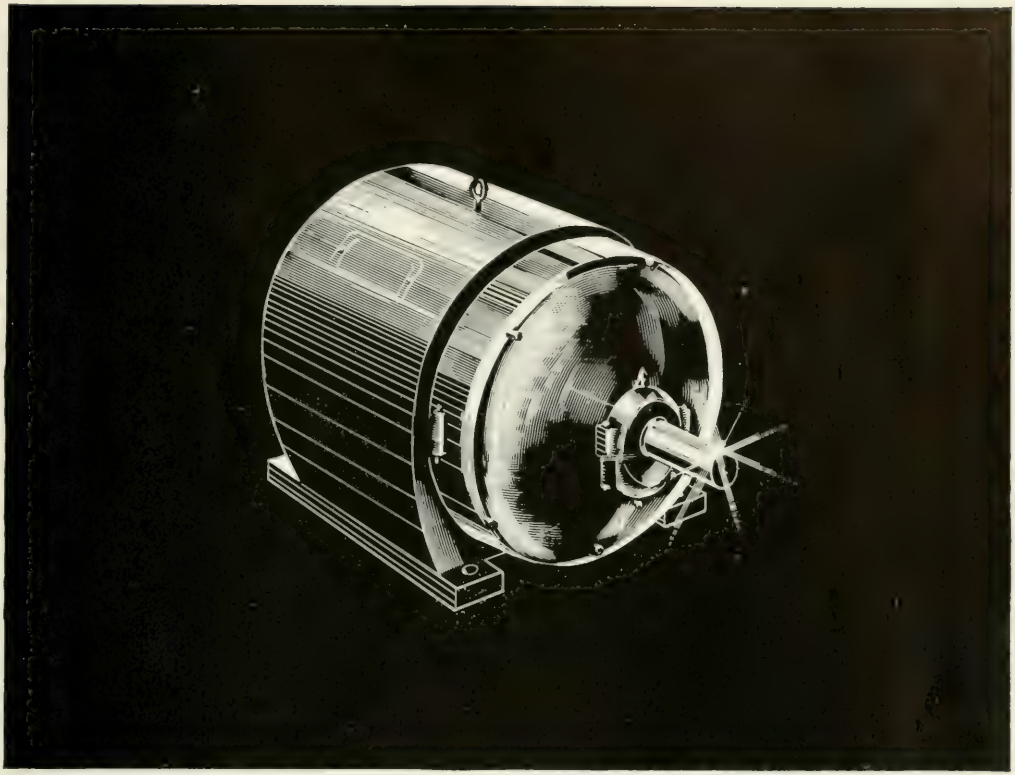

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HEADQUARTERS FOR BUSINESS INFORMATION

honorary and society news

by Chuck Wade, m.e. '52

SIGMA TAU

Sigma Tau is one of the two all-engineering scholastic honoraries at the University of Illinois. This organization has a three-fold purpose: (1) to promote engineering progress by providing incentive for and recognition of individual achievement, since progress is manifested chiefly through the advance of outstanding persons; (2) to provide training by service in Sigma Tau leadership. It is true that a person gets from any organization no more than what he puts into it. Service as an officer or committeeman developes leadership to a fine extent; (3) to offer the opportunity for the development of personal and professional friendships.

IAS

The Institute of the Aeronautical Sciences has again had a busy semester. Interesting speakers and films were the highlights of the monthly meetings.

The last meeting of the semester usually consists of two student speakers who give their seminar papers. These students are chosen from the seminar classes, one from each. They are in competition for the Annual IAS Lecture Award the night of the meeting. The winner is then chosen by the faculty and the officers of the IAS.

The IAS was one of the backers of St. Pat's Ball this year. According to the engineers, it was the best dance of the year.

The IAS has recognized the fact that the freshmen and sophomores do not come in contact with the aeronautical engineering instructor until he becomes a junior. During the past semester, the faculty has gotten together with the underclassmen on an informal basis. The purpose of the meeting was not only to introduce the faculty but also to promote interest in the IAS. It is believed that this meeting has produced good results and it is hoped that every semester will find a similar get-together.

Recently elected officers for the fall semester are William Greenfield, chairman; Loren Anderson, vice-chairman; Donald Pfeuffer, secretary-treasurer; Joe Gross, Engineering Council representative; Mr. H. H. Hilton, honorary chairman (Faculty Adviser).

Mr. Hilton has replaced Dr. Coan, who has served as faculty adviser for the past two years and who has done a very commendable job. Mr. Hilton is an instructor in aeronautical engineering and is very well liked by the students.

The yearly dues of this organization are $1.00, and for an additional fifty cents, a sharp looking pin may be obtained. Upon graduation, if the member is in good standing with the IAS, the member becomes a technical member of the parent organization.

PI TAU SIGMA

Pi Tau Sigma is the National Mechanical Engineering Honorary. Illinois Alpha, the first chapter of Pi Tau Sigma, was founded in the year 1915 by a group of upperclassmen who desired an honorary fraternity for mechanical engineers. These men accordingly formed the first chapter of an organization which would exist "to foster high ideals of the engineering profession, to stimulate interest in coordinated departmental activities, and to promote the welfare of its members."

The key to the fraternity is scholarship, but scholarship in itself is not sufficient—the men pledged to Pi Tau Sigma should participate in extracurricular activities. This participation in extracurricular activities provides the social adaptability which is so necessary to a well-rounded personality.

Such participation also affords students to become better acquainted with each other as well as the faculty. This is a very important aspect of the organization, for in a large university such as Illinois it is not an easy task to become well acquainted with those with whom you come in contact.

The Spring Initiation Banquet for 1950-1951 was held May 2, 1951, in the University YMCA. At that time, twenty-three men were brought into the organization.

The new officers for the fall semester of 1951-1952 school year are Ed Fort, president; Don Bahnfleth, vice-president; Charles Hudson, treasurer; Henry Price, recording secretary; Dick Parrill, corresponding secretary; M. M. Hammadat, council representative.

SBACS

The University of Illinois Student Branch of the American Ceramic Society (or SBACS, as it is popularly abbreviated) is the "bonding agent" of campus ceramists. Year after year, the SBACS boasts that its members consist of 90-92 per cent of the students enrolled in the ceramic engineering department.

In addition to working with the Engineering Council and with other professional societies, the SBACS provides social activities and extra-curricular educational programs for its members. The highlight of the years social activities is the annual Pig Roast which is held each spring. Guest speakers from throughout the ceramic industry are invited to speak before the monthly meetings. During the year 1950-1951 the SBACS sponsored the continuation of the revival of the departmental yearbook—*The Illini Ceramist*. This yearbook is distributed to students and to alumni in all parts of the world.

TRIANGLE

Triangle fraternity is a national social fraternity of engineers and architects. Triangle was founded here at the University of Illinois in 1907. Since then, it has expanded to 17 chapters, most of them being located at every Big Ten school except Michigan State and Indiana. Although scholarship is naturally of major importance to the fraternity, Triangle tries to give its members a well-balanced college life. Participation in extracurricular activities is encouraged, and Triangle maintains a complete intramural program in almost every sport. On the social side, the fraternity holds four or five dances a year, with the big dances being the Christmas Dinner Dance and the Spring Formal.

The Triangle chapter house is lo-

(Continued on Page 38)

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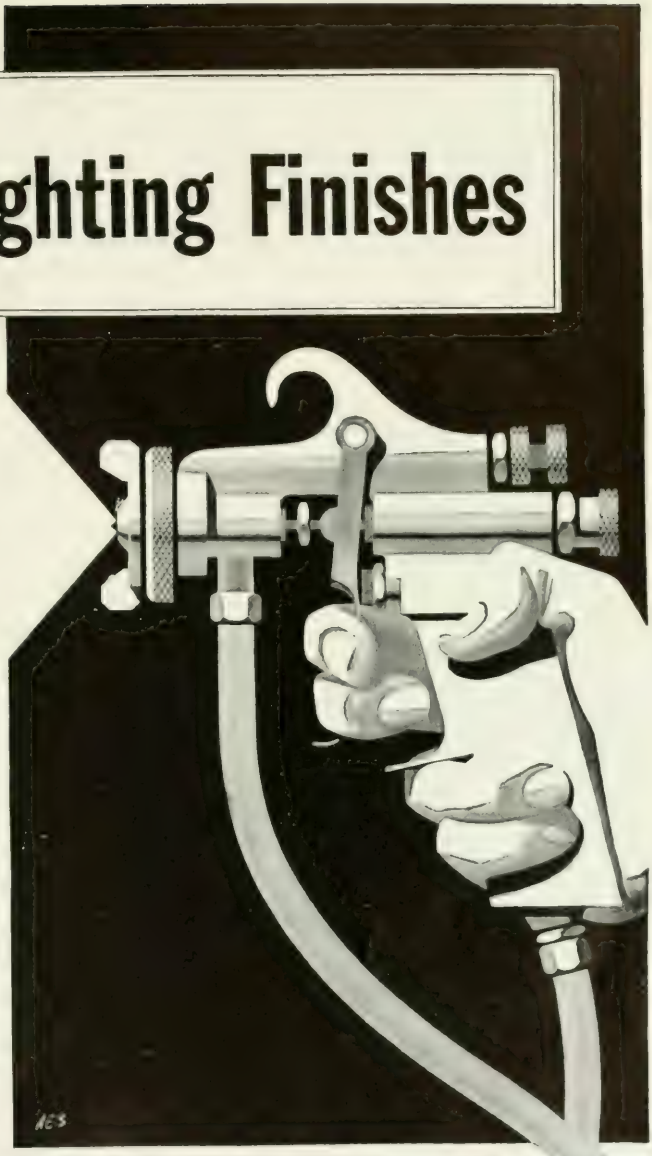

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by Bob Schrader, m.e. '54

An engineer is a person who passes as an exacting expert on the basis of being able to turn out with prolific fortitude an infinite series of incomprehensible formulas calculated with micrometric precision from vague assumptions based on debatable figures taken from inconclusive experiments carried out with instruments of problimatical accuracy by persons of dubious character and questionable mentality for the avowed purpose of annoying and confounding a hopeless commercial group of esoteric fanatics referred to all too frequently as "practical engineers."

* * *

Flush Ye Boneyard

* * *

Doctor Rodebush of the physical chemistry department tells this one. A question on one of his tests concerned the difference between the oscillation of lead and carbon molecules at low temperatures. One of the answers to this question clearly stood out above all the rest. It read, "The frequency of osculation is much greater for diamonds."

* * *

Flush Ye Boneyard

* * *

Potentially, one of the biggest aids to the engineering freshman or sophomore is his engineering society. All the contact that most freshmen and quite a few sophomores get with engineering are a few slide rule and drawing courses. This lack of contact with engineering could be partially filled by the engineering societies. However, the fact remains that few freshmen and sophomores take an active part in their societies. Few underclassmen seem to realize that they are missing a valuable part of their education.

For the benefit of freshmen and transfer students, a list of the various engineering societies on campus follows:

The American Foundrymen's Society
American Institute of Electrical Engineers—Institute of Radio Engineers
American Institute of Chemical Engineers
American Society of Agricultural Engineers
American Society of Civil Engineers
American Society of Mechanical Engineers
Institute of the Aeronautical Sciences
Illumniating Engineering Society
Institute of Traffic Engineers
Mineral Industries Society
Society of Automotive Engineers
Student Branch of the American Ceramic Society.

* * *

Flush Ye Boneyard

* * *

In the May issue of the *Technograph*, the *Bilge* printed a list of different engineering curricula and the number of students in them. But, we made a terrible omission. We forgot the engineering physics curriculum. Our apology goes out to the eighty-some engineers in engineering physics here on campus. Also, a special apology goes to editor Hank Kalapaca, who also happens to be in engineering physics.

* * *

Flush Ye Boneyard

* * *

"Girls, if you want to be happily married, pick out a chemical engineer. If possible, get one between 28 and 30, who goes to church and Sunday school and has plenty of friends, although not too many of the opposite sex. If you can't find a chemical engineer, next best choice is a minister or college professor. But don't marry a traveling salesman or a mechanic unless you want to run the risk of being only half as happy or maybe five times as unhappy."

No, this isn't an excerpt from an "advice to the lovelorn" column. It is a conclusion based on nine years of scientific research, as presented in the book, *Predicting Success or Failure in Marriage*. A survey was made of the marriage happiness rating for 60 different occupations, and chem engineers came out on top. Now, let's hear what the other branches of engineering have to say on this.

—*Stolen from the Texas A. & M. Engineer.*

* * *

Flush Ye Boneyard

* * *

Sad is the lot of the student: How about the ME who was accused of cheating in a tough hour exam simply because he had broken his watch and kept looking over at the man next to him just to see how much time he had left?

* * *

Flush Ye Boneyard

* * *

And then there was the engineer who called his girl the indefinite integral because she had no limit.

—*The Cornell Engineer.*

* * *

Flush Ye Boneyard

* * *

Lives there an engineer with soul
so dead
Who never to himself has said
To hell with these studies
I'm going to bed.

—*Kansas State Engineer*

* * *

Flush Ye Boneyard

* * *

When an eastern firm received word that one of its salesmen had been found dead in San Francisco, it wired:

"Send samples back by freight and search the body for orders."

THE DU PONT DIGEST

M.E.'s AT DU PONT

Diversity of chemical products spells opportunity for the mechanical engineer

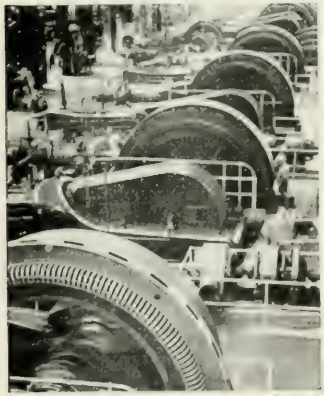
Students of mechanical engineering sometimes assume there is little opportunity for them in the chemical industry. In fields where products are made in more or less standardized equipment, this may be so.

But in a company like Du Pont which operates in many fields of industrial chemistry—where products are made at pressures over 15,000 pounds per square inch as well as in vacua low as two millimeters of mercury—mechanical engineers are in heavy demand.

What jobs do they fill at Du Pont? Literally hundreds, not including the normal run of mechanical engineering work such as design of standard equipment, scaling up from blueprints, etc.

For example, here are some of the problems encountered in the manufacture of nylon yarn alone:

1. Nylon polymer, a poor thermal conductor, is melted by a contact surface grid at 550°F. The polymer decomposes slowly at this temperature, and there is a major heat-transfer problem. Many types of melting grids had to be designed before one proved satisfactory.



The compression *stages of these 50 ton-day hypercompressors (15,000 p.s.i. for nitrogen, hydrogen, etc.) were designed by Du Pont mechanical engineers.*

2. The molten polymer is pumped to spinnerets under pressures over 1000 pounds per square inch. With nylon as the only lubricant, the pumps must operate continuously at 550°F. Specialized problems in sealing, gasketing and materials of construction are inherent in this operation.

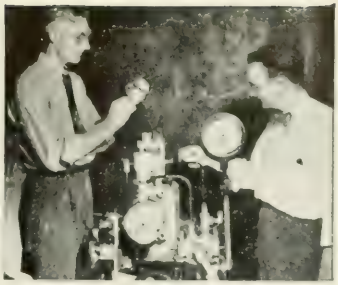
3. The melt is forced through multiple holes (diameters of 7 to 22 thousandths of an inch) in a special alloy disc. They must be made to conform to "jeweler's specifications."

4. The emerging fibers are cooled in a specially designed "air conditioned" chimney. Precise control is essential in this critical operation.

5. The fibers are wound on spools at surface speeds around 1000 yards per minute. Design calls for constant change in speed so that there is no localized stretching or relaxation of the fiber.

6. Finally, the fiber is drawn about 400% and wound on spools traveling at 5000 feet per minute. Bearing lubrication and dynamic balance presented important design problems.

These are but a small part of the mechanical engineering problems arising in the manufacture of a single product by only one of Du Pont's ten manufacturing departments. Literally hundreds of other products, ranging all the way from cellulose sponges to metals like titanium, present similar challenges. So long as new processes continue to be sought and old processes improved, there will be important work for the hand and mind of the mechanical engineer.



Ralph C. Grubb, *B.S.M.E., Tennessee '51, and Paul D. Kohl, B.S.M.E., Purdue '46, study characteristics of a super-pressure pump (75,000 p.s.i.) designed by Du Pont engineers and made in Du Pont shops.*

Heat-transfer *problems in the design of new fiber-spinning equipment are investigated by J. C. Whitmore, B.S.M.E., Virginia '44, M.S.M.E., Delaware '49, and L.B. Collat, B.S.M.E., Georgia Tech '50.*

Uniquely designed *adapter for a screw extruder under study by Ralph J. Cox, B.S.M.E., Purdue '49, and John F. Keating, B.S.M.E., Purdue '41. The adapter heats, filters and forms polymer into filaments.*

Send for your copy of "The Du Pont Company and The College Graduate." Describes opportunities for men and women with many types of training. Explains how individual ability is recognized and rewarded under Du Pont plan of organization. Address: 2521 Nemours Building, Wilmington, Delaware.

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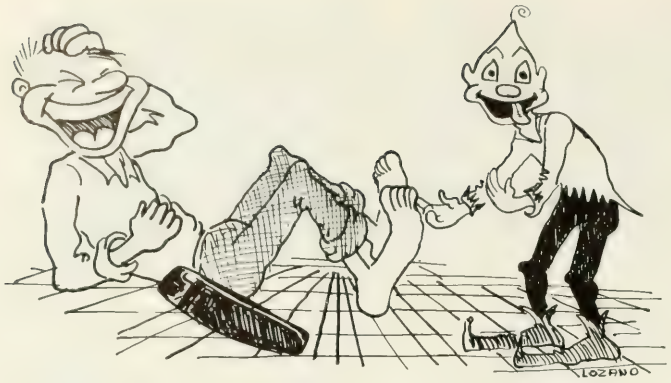

TECHNOCRACKS

I had twelve bottles of whiskey in the cellar and my wife told me to empty the contents of each bottle down the sink—or else. I proceeded to do the unpleasant task.

I withdrew the cork from the first bottle and poured the contents down the sink, with the exception of one glass which I drank. I extracted the cork from the second bottle and did likewise, with the exception of one glass which I drank. I withdrew the cork from the third bottle and poured the contents down the sink with exception of the glass which I drank.

I pulled the cork from the fourth sink and poured the bottle down the glass which I drank. I pulled the bottle from the cork of the next and drank one sink of it out, and threw the rest down the glass. I pulled the sink out of the next glass and poured the cork from the bottle. Then I corked the sink with the glass, bottled the drink and drank the pour. When I had everything emptied, I steadied the house with one hand, counted the bottles, corks, glasses and sinks with the other one, which were twenty-nine and as the house came by I counted them again, I finally had all the houses and one bottle which I drank.

I'm not under the alcofluence of incohol, but some thinkle peep I am. I'm not half as thunk as you might drink. But I fool so feelish—I don't know who is me and the drunker I stand here the longer I get.

* * *

Student: "Could you help me with this problem?"

Professor: "I could, but I don't think it would be quite right."

Student: "Well, take a shot at it anyway."

Tom Harris: "What's the matter with your fingers?"

Tony Babykin: "Oh, I was downtown getting some cigarettes yesterday and some clumsy fool stepped on my hand."

* * *

"Porter, get me another glass of ice water."

"Sorry suh, but if I takes any mo' ice, dat corpse in de baggage car ain't gonna keep."

* * *

Little Audrey, mad as hell,
Pushed her sister in the well.
Said her mother drawing water,
"Gee, it's hard to raise a daughter."

* * *

Customer: "Barber, have you got another razor?"

Barber: "Sure I have. Why?"

Customer: "I'd like to defend myself."

* * *

All those who think that "evening" means the same thing as "night" should note the effect that it has on a gown.

* * *

Waiter: Why are you washing your spoon in the fingerbowl?

Customer: So I won't get egg all over my pocket.

* * *

"Who was that lady I saw you with last night?"

"That was my brother; he just walks that way."

A grave digger, absorbed in his thoughts, dug the grave so deep he couldn't get out.

Came nightfall and the evening chill, his predicament became more and more uncomfortable. He shouted for help and at last attracted the attention of a drunk.

"Get me out of here," he shouted. "I'm cold."

The drunk looked into the grave, and finally distinguished the form of the uncomfortable grave digger.

"No wonder you're cold," he said. "You haven't any dirt on you."

* * *

Lawyer: "What if a man IS on his hands and knees in the middle of the road? That doesn't prove he's drunk!"

Policeman: "No, sir, it doesn't. But this one was trying to roll up the yellow traffic stripe."

* * *

A drunk in the Empire State Building stepped into an elevator shaft and dropped thirty stories to the basement. When he landed, he shook his fist and remarked, "I shaid up, not down!"

* * *

The ME instructor held the chisel against the rusted bolt. He looked at the ME student and said, "When I nod my head you hit it."

They're burying him at noon today.

* * *

"Waiter," said a testy patron. "I must say I don't like all the flies in this dining room."

"Tell me which ones you don't like," said the conciliatory waiter, "and I'll chase them out for you."

* * *

She: "Don't you wish you were a barefoot boy again?"

He: "Not me, lady, I work on a turkey farm."

* * *

"Say, do you know an easy way to find out the horsepower of a car?"

"No. How?"

"Lift the hood and count the plugs."

* * *

As he felt his way around the lamp post, the overloaded senior muttered, "S'no use, I'm walled in."

* * *

Pat: "How did Brother Jones die?"

Mike: "He fell through a scaffolding."

Pat: "What was he doing up there?"

Mike: "Being hanged."

ELECTRICAL WIRE AND CABLE

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ROEBLING is the best-known name in the whole field of wire and wire products . . . and from their copper conductors to their protective jackets, Roebling electrical wires and cables are produced entirely in Roebling plants. There's a complete line, too . . . more than sixty standard types representing the best that is known today in materials and construction . . . assuring maximum dependability and utmost economy on the job.

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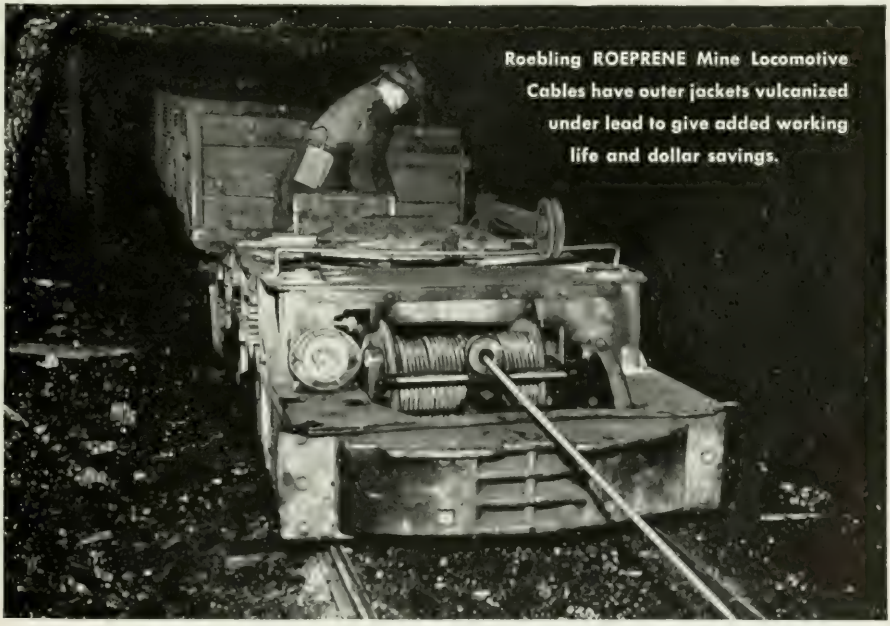

Roebling ROEPRENE Mine Locomotive Cables have outer jackets vulcanized under lead to give added working life and dollar savings.

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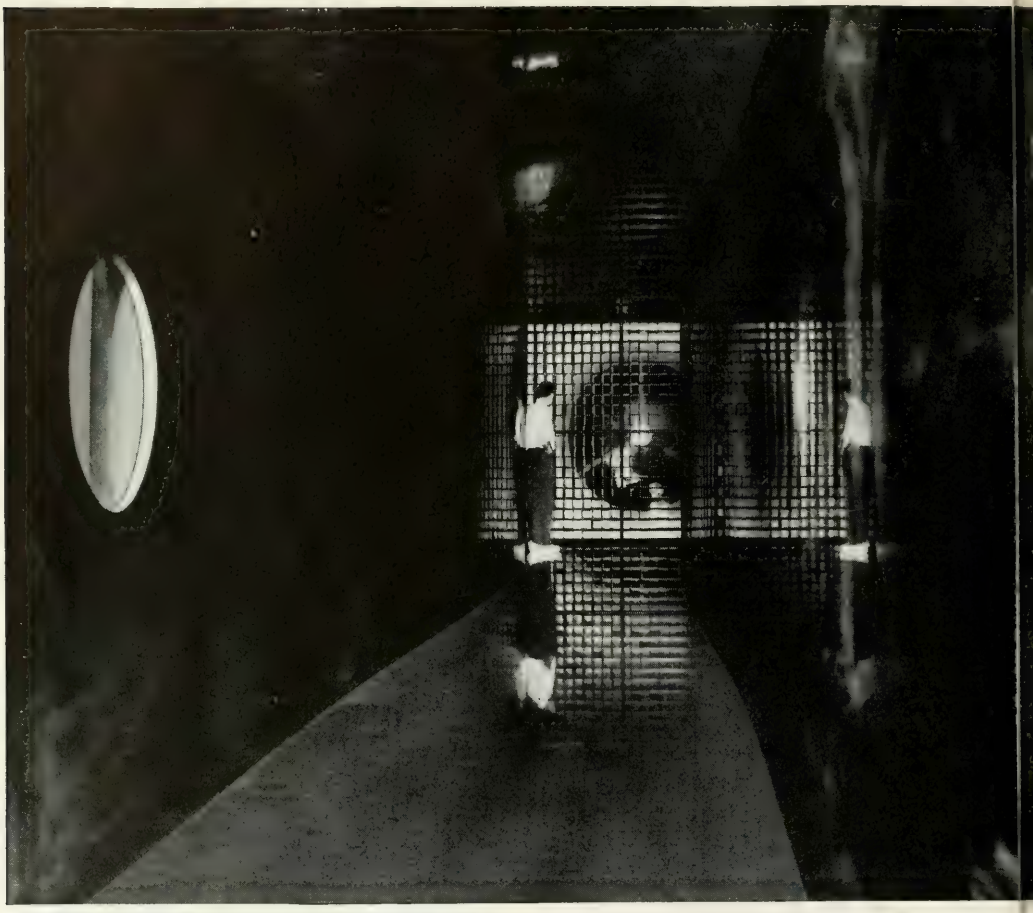
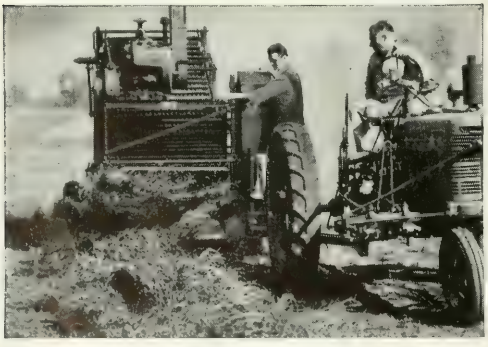
Only STEEL can do so many jobs





CAVE OF THE WINDS. This largest "supersonic" wind tunnel in the world—at the National Advisory Committee for Aeronautics, Lewis Laboratory, Cleveland—is capable of providing air velocities up to twice the speed of sound for aeronautical research. The tunnel's testing chamber measures 8 by 6 feet and has flexible walls of highly-polished U·S·S Stainless Steel plates, specially made by U.S. Steel for this vital defense project.

NEW WAY TO GATHER GOOBERS. This new peanut combine threshes along the row where the peanuts are grown, gathers up nut-laden vines, picks them clean, and deposits the mulch to condition the soil for the next crop. In tests, it has reduced harvesting man-hours per acre from 30 to 4, lets two men do the work of 12, saves $40 an acre. By supplying steel for such equipment, U.S. Steel helps build a more productive America.

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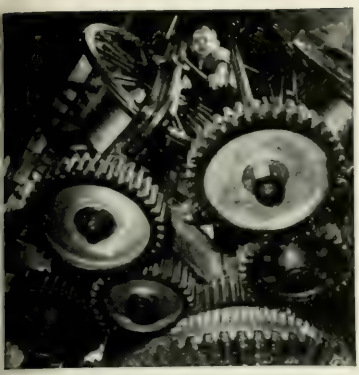
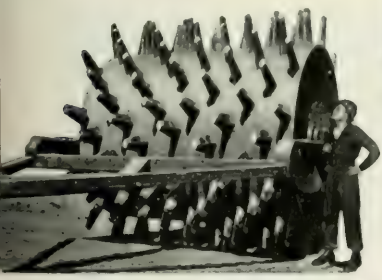
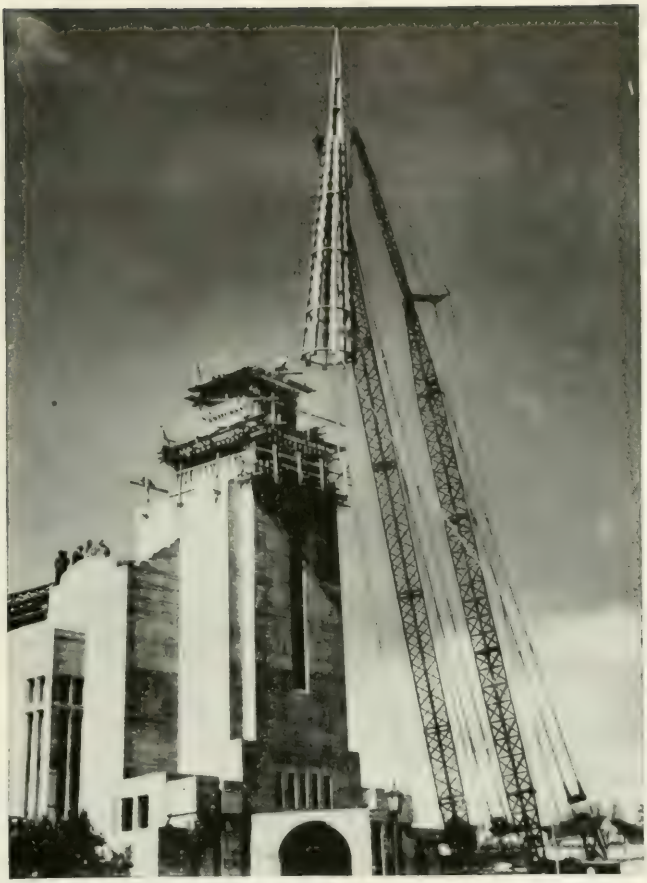
so well...



WHEELS WITHIN WHEELS. Here you are looking into the driving gears of a 10-ton vertical closing machine, making U·S·S TIGER BRAND Elevator Rope to lift and lower the elevators in many of our country's famous skyscrapers. This equipment also manufactures general hoisting rope for applications such as the cranes shown in illustration at right. Whether you need enormous steel cables to support a bridge, or wire that's finer than a human hair, United States Steel manufactures a wire suited to your special requirements.



GIANT SHEEPSFOOT ROLLER. Army Engineers find this odd-looking, 36-ton steel roller a very useful tool for compacting and leveling off fill in the construction of airstrips. Although the defense program will require increasing amounts of steel, the constantly-expanding steel-producing facilities of United States Steel should enable it to supply steel for many essential everyday uses, too.



HOW TO SWING A STEEPLE 80 FEET UP. Here are two cranes completing the 80-foot lift of a prefabricated steel steeple, and about to swing it over its base. United States Steel has won a world-wide reputation as fabricators and erectors of steel work for everything from football stadia to church steeples, from bridges to television towers.

FACTS YOU SHOULD KNOW ABOUT STEEL

In 1951, the American steel industry must be able to purchase 30 million tons of high grade scrap outside the industry, if it is to achieve the record steel production goals set for it by our defense program. Memo to manufacturers, farmers and proprietors of auto "graveyards": Turn in your scrap! It means money for you, more steel for America!

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COLD WAR . . .

(Continued from Page 9)

something which is proportional to the average kinetic energy of the particles in a given volume of a substance, a gas being the simplest case.

One point that must be emphasized is that the numbers associated with different temperatures are completely arbitrary. For example, on the Centigrade scale the boiling point temperature of water at standard conditions is 100, and the freezing point is 0. These temperatures, however, could have been reversed without altering the concept of temperature the least bit. This fact should not be surprising since most of our scientific measuring standards (liter, meter) are completely arbitrary units.

Early Research

The study of low temperature phenomena has a comparatively short history. In 1714, Gabriel Fahrenheit, a German scientist, achieved with a mixture of ice and salt what he thought was the lowest possible temperature. He called this point zero and used it as a basis for a temperature scale—the Fahrenheit scale.

Obviously, Mr. Fahrenheit didn't get around much, for it was soon discovered that Nature herself produced temperatures lower than the so-called zero point. Consequently, he had to introduce minus signs into his newly formed temperature scale. It wasn't until 1848 that a really suitable temperature scale for low temperature study was developed. In that year, Lord Kelvin, an English scientist, proposed his "absolute" scale. This scale has the same divisions as the Centigrade scale except that it starts with absolute zero as the lowest point, and works its way up.

The initial interest in very low temperatures was created chiefly by the desire to liquefy the so-called permanent gases such as nitrogen, oxygen, hydrogen, and helium. Helium, the last to yield, was liquefied in 1908 by a Dutch scientist at a temperature of –270°C.

Attaining Low Temperatures

Methods and apparatus for securing refrigeration at very low temperatures have received a large fraction of the scientific effort expended in this field up to the present time.

There are three important physical principles used in the production of low temperatures: (1) the dependance of the internal energy of a system upon its temperature and its volume; (2) performance of external work during an expansion, when the system exerts pressure upon a moving boundary; and (3) performance of external work during demagnetization, when the system returns energy to the magnetizing agent.

When a body of gas is compressed adiabatically, that is, without exchange of heat with the surroundings—it becomes hot. This is so mostly because of the work expended upon it, but also by virtue of the fact that the specific internal energy of a dense gas is less than that of the same gas in expanded form. Likewise, when a flask of compressed air is opened to the atmosphere and the pressure allowed to equalize, the air remaining in the flask will be quite cold. Those readers who are familiar with carbon dioxide cartridges will quickly verify this fact. The gas becomes cold principally because of the external work performed in pushing back the atmosphere and in accelerating the fraction of the air which was ejected.

If one wishes to supply refrigeration continuously, a cyclic process must be substituted for the intermittent charge and discharge of the free-expansion method of cooling.

The free-expansion method of cooling worked fine down to about one degree above absolute zero. At this point, however, this method became highly impractical. Scientists were puzzled for a long time as to how they could reduce the temperature of a substance below 1°A (absolute). Finally, a scientist by the name of Giauque solved the puzzle. He postulated that since external work is done upon a substance when it is magnetized, there should be a rise of temperature when the process is carried out adiabatically, and a corresponding fall in temperature on demagnetization. The basic idea was simple: magnetize the proper chemical, and—while keeping it magnetized—cool it down to the lowest temperature obtainable. Then, demagnetize it. Cooling by adiabatic demagnetization has thus opened up a temperature range not attainable by older methods. The chief deficiency of this method is the fact that the low temperature reached is a transient condition. The cold salt begins to grow warmer immediately.

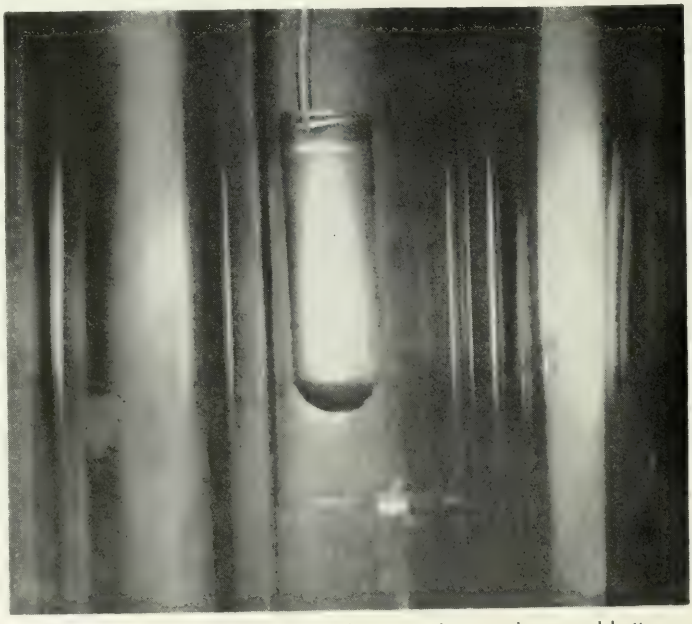
The method of demagnetizing the atoms of a substance (usually a paramagnetic salt) works fine to about .002°A. At this point, scientists use the magnetic properties of atomic nuclei. When certain materials (such as lithium fluoride) are placed in a strong magnetic field, the nuclei of their atoms line up. This method promises to yield a temperature only one-millionth of a degree above absolute zero.

To understand how difficult it is to set up some of these very low temperature experiments, one has only to look at a report of one of Giauque's recent ordeals. He and his assistants started one experiment at 7 o'clock Saturday morning and ended at 6 o'clock on the following Monday afternoon. They did not sleep or even stop to eat.

Measuring Low Temperatures

The preparation of suitable temperature-measuring devices for use at low

(Continued on Page 34)



Creeping film appears as a tiny luminous drop on the curved bottom of a vessel filled with liquid helium.

Electron tubes are the nerve cells of military intelligence—in systems set up and maintained by RCA Service Company field engineers.

Electron Tube with a military mind

With the rapid advance of airplanes, tanks, fast ships, and mechanized weapons of war, a swift, sure means of *communication* and *detection* is as important as are the new weapons themselves. It is provided—by electron tubes and electronics.

So important is this area of military intelligence that RCA Service field engineers have lifted their efforts to new peaks. Working with our Armed Forces, they install and maintain such *communications systems* as shortwave radio and portable radiotelephones. They work with systems of *detection*, such as radar. They help ships and planes *navigate* with loran and shoran. These engineers are the link between research developments made at RCA Laboratories—and America's military strength.

The number of RCA field engineers has *tripled* since World War II. And they serve where needed, wherever an electron tube's "military mind" can be of military use.

* * *

See the latest wonders of radio, television, and electronics at RCA Exhibition Hall, 36 West 49th Street, N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, N. Y. 20, N. Y.

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- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
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Write today to College Relations Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RADIO CORPORATION of AMERICA

World Leader in Radio—First in Television

PHOTOGRAPHY . . .

(Continued from Page 11)

of a material not detectable by any other means.

The essential details in carrying out such a spectrographic analysis are so much less complex than the conventional chemical one that standard production and material receiving analysis can be effected without costly delay.

The average camerist would not have sufficient equipment to perform a spectrographic analysis of the type described, but his necessary knowledge of light and optical principles would serve as an excellent background for the use of this technique. The special emulsions available for this field of photography are many and complex, rendering the usual camera almost useless except for extremely simple and rough methods of analysis.

Photomicrography has become one of the metallurgist's most useful tools. The grain structure of metals, for example, is an indication of the uses to which these metals can be put. Machinability, hardness, strength, and even the approximately chemical composition of the sample are all revealed by a photomicrograph.

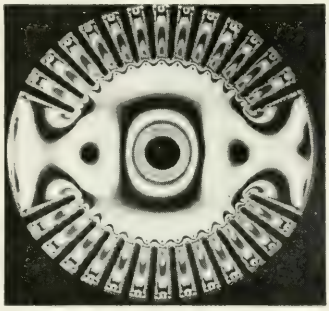
Many diverse industries use photomicrography as a basic tool in their manufacturing and research departments. The molding of plastics, the durability and weather-resistance of paints and varnishes, the strength of building materials, and the usefulness of a wide variety of other products have been and are being improved by including photomicrography with other basic methods. This function of photography should not be regarded as a research tool only. It is equally valuable in the production, design, and inspection of a great variety of products.

The engineer who owns one of the many miniature cameras that will accept extension tubes and microscope adapters can use it very effectively on many occasions for the close scrutiny of engineering materials. The main difference that he will have to consider is that the exposures in this phase of photography are measured in minutes instead of seconds. With a little time and patience, however, good photomicrographs can be made with this type of miniature camera.

What the microscope has done to aid in the examination of objects too small for the unaided eye, high speed motion pictures are doing to slow down action time of objects whose motion is too fast for investigation. It has become a valuable tool in the fields of thermodynamics, mechanics, and other studies in the research which precedes the development or improvement of a product or process. For example, high speed motion pictures have proved extremely valuable in investigations on the flow and mixing of fluids, elasticity studies on rubber, research on fuel injection and combustion, the behavior of explosive chemical mixtures—in fact, wherever motion exists that is too fast for the human eye to analyze.

Essentially the camera for high speed motion pictures is similar to the one used in the home. However, where the home camera exposes 16 frames per second, the high speed camera exposes up to 10,000 frames per second. When this film is projected at the normal speed of 16 frames per second, the elapsed time of one second can be stretched to more than ten minutes. And being on film, the record can be viewed as often as desired, and by as many people as necessary. Time magnification, through the application of functional photography, has become a new tool for the engineers of every industry.

High speed motion pictures are easy to set up, easy to make, and simple to project. Nearly everyone who has handled any type of camera and follows



A stress pattern is determined by polarized lighting.

directions can make acceptable high speed motion pictures. The home motion picture camera with the slow motion speeds of 64 frames per second may be used for slowly moving objects, but a special camera is a prerequisite to true high speed motion pictures.

This article has listed and partially explained relatively few of the uses of functional photography that should interest the engineer, and that he is capable of performing and understanding. However, I hope that it has provided food for thought for my fellow camera-snapping engineers, and perhaps suggested a few new ways to "snow" your favorite instructor.

E.E. (on phone): "Hello, is Gertie in?"

Voice: "She's taking a bath."

E.E.: "Sorry, I have the wrong number."

THEMES . . .

(Continued from Page 13)

been met in a number of ways—short piles compensating for excavation, spread footings, mat foundations, and long piles to dependable deep strata.

Surrounded by mountains, Mexico City lies on a plateau at an altitude of about 7400 *ft* above sea level. Originally the plateau had no outlet through which the rain water could escape. The only loss of water was by evaporation with the result that a lawe was formed, the bed of which gradually rose. Excavations have been carried to nearly 2,000 *ft* and the solid rock on which the first sediments were depositied has not been found. Some fair bearing material exists at 112,230 *ft* and it is this depth that must be studied for foundations for tall buildings. A geologic profile taken in the center of the city shows clay strata interrupted by thin layers of volcanic sand. Since there is a definite lack of uniformity in geological profiles taken in different parts of the city, conditions at the site of every building must be thoroughly investigated.

There are two types of ground settlements in the city—a general subsidence of the whole area, and settlements due to local causes. The general subsidence first started about 1790 when the plateau was first drained. Local settlements are caused by the weight placed on the soil by buildings or other structures. The clay under the city, although very compressible, behaves elastically up to a certain point; when the stresses of the soil are released, heaving takes place. Drying causes a very large volume change.

Early builders in the city tried to avoid differential settlement and cracking by the use of short piles under the masonry footings. However, whatever resistance there was to differential settlement was provided by the strength of the masonry foundation. In later foundations a wooden grill was built on top of the piles for the support of some buildings. In more recent times, steel grillages have been used.

With the development of reinforced concrete an excellent material was made available for the construction of mat foundations. Part of the weight of the building can be compensated for by the weight of the excavated soil. In the design of a foundation care should be taken to have the center of gravity of the load coincide with the center of the foundation area so as to produce a uniform stress on the soil and therefore, even settlement.

Long wooden piles have been used to transmit the load to sand lenses about 112 *ft* below the ground surface. Since wood piles this long are scarce, sections

(Continued on Page 28)

HERBERT J. RASS

ENGINEER—in charge of OPPORTUNITIES

by HERBERT J. RASS, *Manager, Employment Department*
ALLIS-CHALMERS MANUFACTURING COMPANY (*Graduate Training Course 1942*)

MAYBE that's a far-fetched way of putting it—but I am an engineer (Marquette 1941, Electrical Engineering) and a great many men do pass through the Employment Department to opportunities with Allis-Chalmers. I did the same thing myself.

During my last two years at Marquette in Milwaukee I worked as a cooperative student at Allis-Chalmers on the electrical test floor, in electrical product departments on both design and application work, and in the shops. When I graduated, I continued in the Graduate Training Course, on training location with what is now the Employe Relations Department. After six months—opportunity came around to look me up. The Company officer in charge of Industrial Relations talked to me about personnel work and asked if I'd like to go on with it as a career.

Liked Working With People

By that time I'd seen a lot of the Company, both product design and manufacturing, and I knew I liked working with people better than with machines, so it was just the break I wanted. During the war I was in the shops on personnel work, got a thorough grounding on operations carried on throughout the plant, and made many contacts. In 1950 I was made manager of the Employment Office.

Recruiting engineers for the Graduate Training Course is one of our functions, and perhaps this is a good place to tell something about the course.

The course here is actually tailor-made for each man, and you help plan it. You can work it out to get concentrated training and experience in almost any phase of work that you want . . . even go on and get advanced degrees. Or, like so many of us, you may use it as an opportunity to get experience with many phases of the Company's operations.

Industry's Broadest Range

There are over 75 training locations for Graduate Training Course engineers at Allis-Chalmers' Milwaukee Plant alone. They include research, design and sales application on a wide range of products such as motors and generators, crushing, cement and mining machinery, steam and hydraulic turbines, centrifugal pumps, transformers, electronic equipment and milling machinery.

This is a 7 ft. x 8 ft. x 250 ft. rotary lime sludge kiln. Allis-Chalmers is also an important supplier of kilns to the cement industry.

Giant spiral casing for hydro power project is one way of showing that Allis-Chalmers can build them big.

That's only part of it. You can go into the shops and manufacturing end of the business—work in planning and production control, personnel, time study, wage determination and labor relations. Or, there's laboratory and research, purchasing, advertising, sales training, export sales. Somewhere during the two-year course you're going to get a start in the work that suits you best. If you have the stuff, opportunity is going to come your way.

If you'd like more information about the Graduate Training Course, stop in for a visit at your nearest Allis-Chalmers district or regional office—or write for literature.

ALLIS-CHALMERS A-C

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin

RESEARCH . . .

(Continued from Page 12)

pounds pressure; a half-dozen strips of lead sheathing being bent back and forth slowly, once an hour; another half-dozen being bent more rapidly, 10 minutes for each complete bend; and 108 strips hung with varying weights to study long-time stretch.

From these tests, which include various alloys, come many valuable facts. Some of them surprise even Professor Dollins.

One of these surprises is on a rack which holds nine lead sheath specimens each ¼ *in.* wide and 10 *in.* long. On them 11 to 22 *lb.* weights have been hung since 1939. The stress is 300 to 800 *psi.* According to calculations the specimens should have broken nine years ago. One speciment—the tenth in the set—did. As for the remaining nine, Professor Dollins is patient, and when they do part he will have some more new facts.

Probing the Atom

The "heart" of a gold atom is three-tenths of a trillionth of an inch in diameter. Between the inch marks of a ruler you could line up 3,300,000,000,000 of them.

This measurement and other data which supports recent theories about the atomic nucleus were reported by a team of University of Illinois scientists.

Gold was one of the elements used in their research because it has a large nucleus. Their findings about its size and about distribution of the electrical charge within it are helping science to a clearer picture of how matter is organized. They also made similar studies with silver, copper, aluminum, and carbon, all of which have smaller atoms.

Some scientists have held that a nucleus consists of a shell of positively charged protons around a center of uncharged neutrons. Others have believed that the protons and neutrons are mixed together in a ball-shaped mass. The Illinois data supports the second theory.

For probing into the atom the men used a newly developed research tool, a beam of carefully controlled high-energy electrons from the University's 22-million volt betatron. They had it set at a precise 15.7-million volts, in contrast to roughly 2-million volts used elsewhere for earlier studies on this subject.

Conducting the experiments were Prof. Ernest M. Lyman, Prof. Alfred O. Hanson, Merril B. Scott, and Lawrence H. Lanzl. They presented their findings in a series of four papers.

Now they are looking forward to making similar studies with electrons from the University's new 340-million volt betatron, largest instrument of its kind in the world.

Astronomical Dust

Prof. Robert H. Baker, University of Illinois astronomer, has a dust problem, and the dust is 6,000 light years away, or thereabouts.

For more than 12 years, Professor Baker and other astronomers have been making a statistical study based on photographs of "the bright girdle around the sky" which is called the milky way. The chief object of the study is to determine the details of this system of stars which is in our vicinity.

Now the astronomers are into a lot of dust "out there." The dust dims and reddens the stars behind it—like the setting sun. Somehow the astronomers must find just where the dust is, and how much, and literally sweep it out of their problem with a scientific broom.

The U. of I. astronomer has been studying the Galactic system ever since joining the University faculty 28 years ago. In fact, he and his predecessor, Dr. Joel Stebbins, who was in charge of astronomy work at the U. of I. for 20 years, are the only men who have headed extensive research projects at the University observatory, built in 1896. Dr. Stebbins pioneered in use of the photoelectric cell for accurately measuring the brightness of stars. The earlier cells he used were developed by the late Dr. Jacob Junz of the U. of I. physics department. The Kunz cells were known for their high sensitivity to light.

Although the main observatory once was an isolated structure, it has been overrun by rapidly spreading University buildings. It still is used by students intent on studying the moon and planets, but when Dr. Baker does his night-time photography work, he goes south of the campus to a smaller observatory located out-in-the clear on the University farms.

Why have Dr. Baker and his coworkers in this country spent years in star-gazing, concentrating on "our" milky way?

"There aren't many geniuses among us," the U. of I. professor replies. "Each does his job and hopes to contribute significant findings. It's a lot of fun, really, but what is more important, we would like to find out about the sort of place in which we're living. Others to follow will explore more deeply into the galactic system. So far, we have just reached the suburbs—and now we're getting into all this dust."

Amateur star-gazers everywhere are familiar with Professor Baker's book, *When the Stars Come Out.* His *Astronomy* is now in its fifth edition. He has written also, among other volumes, *Introducing the Constellations,* and *An Introduction to Astronomy.*

Some persons relax at the movies. Dr Baker finds rest and enjoyment in "writing another chapter."

THEMES . . .

(Continued from Page 26)

must be carefully spliced together. Care should be taken to have the upper portion of the pile made of concrete to avoid decay to that part which is above low water table.

Long concrete button-bottom piles are now being driven for the first time in Mexico City for the newer buildings. These piles are cast in place in a corrogated shell which is inserted in a driving casing. At the bottom of the driving casing is a concrete plug which forms the bottom of the pile. After the corrugated shell has been filled with concrete the driving casing is withdrawn from the ground. This type of pile will keep the building from settling, but as the gradual settlement of the area takes place, it will leave the ground floor above the surrounding ground.

Although a variety of foundation methods have been tried with varying success, Mexico City's foundation problem hasn't been solved.

Practical Civil Engineering

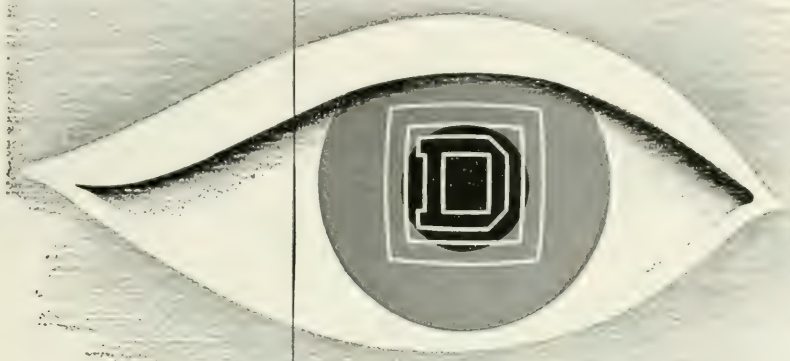
I have been going to school now for four years, and all that time has been wasted if you'd believe some people. It seems that the only thing that does any good is practical experience. You can't design a good shovel until you've dug ditches with one, and after that you don't need a college education to design the thing anyway, or so they say. The same way with highways, potato peelers, corset stays; you can't design them if you haven't had some experience with them. So, last summer, I got myself a job as a section hand on the Chicago and Northwestern Raliroad. Certainly, if a budding civil engineer could get practical experience anywhere, it was on the scenic C.&N.W.R.R., "route of the 400."

Well, I got my practical experience! For anyone majoring in shovel handling, I would strongly recommend the railroad. Believe me, nowhere else can you get such a wealth of experience in shovelling and other related arts. Experience of this type is also stimulating to the imagination. As you dig out ties, tamp ties, spike ties, carry ties, or mark ties, your mind is left free to curse ties and people that insist upon the value of practical experience.

Actually, I did learn some things

(Continued on Page 42)

an eye to the future?



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INTRODUCING . . .

(Continued from Page 14)

project. This work of the NDRC was done by civilians chiefly for the Navy, who had a liaison officer attached to coordinate the activities.

Following his participation in this research work, Dr. Slichter returned to Harvard, graduating with a B.S. Degree in 1946. He went on to receive his M.S. in 1947 and his Ph.D. in 1949.

In the fall of 1949, Dr. Slichter came to the University of Illinois. Here he teaches physics 321 and 322 regularly plus physics 103 on the off semester. He also spends much of his time on research work in the general field of nuclear magnetic resonance (radio frequency and micro-wave). This field, known as spectroscopy, is quite new, and was opened up after World War II due to research by the Electronics Board during the war.

Dr. Slichter, who calls himself a "full time physicist," has no major hobbies, but instead finds various ways of using up his spare time. During the summer months he does research work for the Navy under contract.

His reaction on winning the efficient instructor poll was "very pleased and kind of surprised." One must readily admit that Dr. Slichter, who is a member of Phi Beta Kappa and Sigma Psi national honorary fraternities, has had a very successful start in his physics career.

EDWIN B. CHRISTIANSON

Ed Christianson, a February, 1952, graduate and president of the Engineering Council, is a native of Elgin, Illinois.

After his graduation in February from the college of electrical engineering where he is studying communications and electronics, Ed plans to go into communications work. His career may not be immediately interrupted by Uncle Sam's "Greetings" in the way that will affect many of his fellow graduates, because he is a veteran of three years service in the Army. It was his service in the Signal Corps that first caused him to think seriously of communications as a career. After his discharge from the Army he entered the University of Illinois in the spring semester of 1948.

He is a graduate of Elgin High School, where he was an outstanding athlete, lettering in football, wrestling, and track. Immediately after his graduation from high school, he enlisted in the Army and after serving his three-year enlistment, enrolled at the University of Illinois.

EDWIN B. CHRISTIANSON

He has been a busy man since entering the University of Illinois in 1948. Besides maintaining a high scholastic average in the college of engineering, he has been quite active in the Engineering Council, of which he is now president. He is also president of Delta Upsilon social fraternity and an active member of the IRE-AIEE. He was vice-president of the Engineering Council last year and chairman of last spring's Engineering Convocation. He has also served as the engineering representative and the treasurer of the Careers Conferences.

Oxford and Cambridge may have their cricket matches, and Harvard and Yale may have their big football game; but Texas A. & M. tops them all. The Aggies have their own slide rule contest.

Every engineering freshman at A. & M. must take an engineering problems course. The top ten per cent of the students in this course are selected to compete in the annual Slide Rule contest. At the contest each participant is given sixty problems to do in fifty minutes. The problems are generally somewhat like this one: $\frac{(18.3ft)\ (\sin 18^\circ)}{\sqrt{0.43}\ (\tan 61^\circ)}$. Both speed and accuracy are taken into account, so the winner is the man who gets the most problems right in the time allotted.

Get that saddle off the stove, Ma, you're too old to ride the range.

* * *

When they kiss and make up, she gets the kiss and he gets the makeup.

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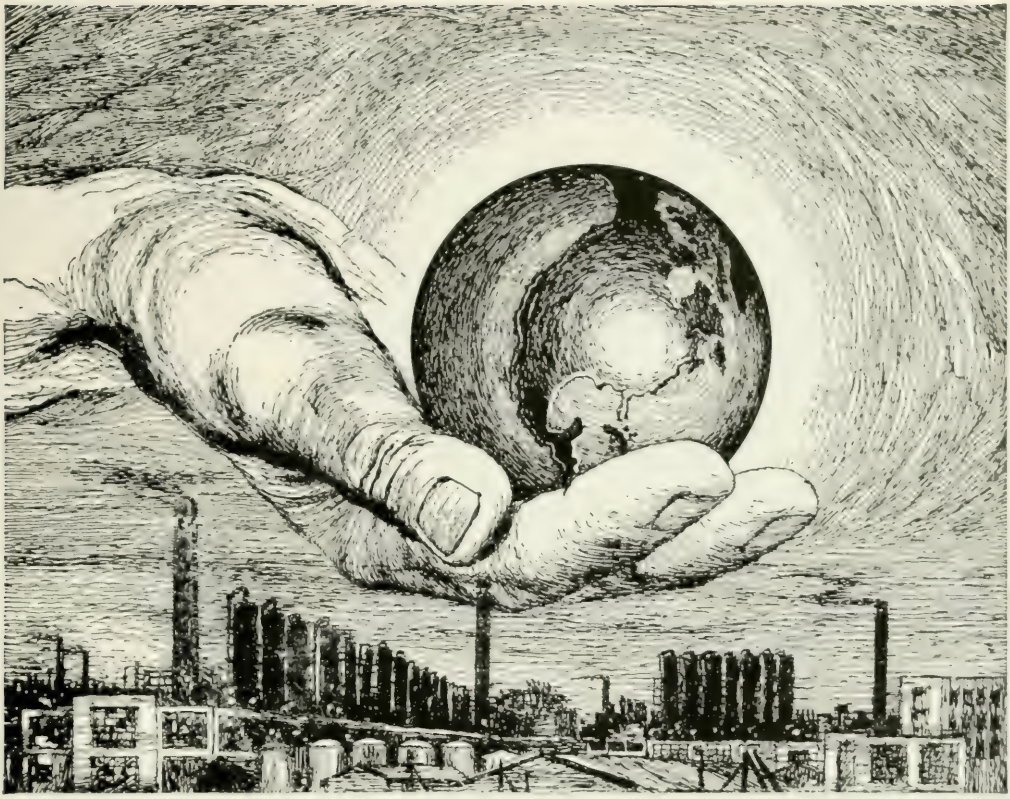

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Vision—75 Years Ago

Though the greatest advances have been made within three decades, the foundation for this progress was laid by the pioneering American chemists who 75 years ago had the vision to form the American Chemical Society. Their society has grown from a handful of members to well over 60,000—the world's largest professional scientific organization. The people of Union Carbide are glad to pay tribute to the American Chemical Society on its Diamond Jubilee, and on the occasion of the World Chemical Conclave.

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SKIMMING . . .

(Continued from Page 2)

physical and chemical make-up of stars will be determined. The optical system will also be capable of analyzing stars of low magnitude.

minute miracle gage

A simple gaging device the size and thickness of a postage stamp can measure minute or extremely heavy loads, dimensional changes of a millionth of an inch, or temperature changes ranging near absolute zero to 1600 degrees above.

The simple device consists of a wire one-third the thickness of a human hair which is wound back and forth, then coated with cement. If the gage is distorted so that the wire is stretched or contracted, its resistance to passage of an electric current is varied. Measurement of the variation tells the exact amount of stretch. The instrument will accurately measure a dimensional change of a millionth of an inch in one inch of length.

One application of the gage is in testing military jet engine blades while they are in operation. The gage is cemented to the blade, a current passed through it, and the engine is run. Any bending of the blade stretches the wire and changes its conductivity, which is then registered on a meter. Thus the engineers can tell exactly what is happening to a spinning blade while the engine is in operation.

new methods in welding

Arc welding, a process of primary importance in fabricating defense materiels such as tanks, planes, and ships, has been greatly improved since World War II by the addition of new methods.

One new method requires the use of inert helium or argon gas. These shield the welding arc and the white-hot area of the weld from the destructive effects of oxygen. Thus, it is possible to weld faster without "burning" the metal and weakening the joint.

In one production line using this method, ¼-*in.* thick bronze plates are welded together with the machine closing 18 *ft.* of seam per minute. In another case, using a tungsten electrode shielded by an inert gas, stainless steel tubes only 1/16th *in.* in outside diameter were welded. After welding, the tubes withstand 500 *psi* of internal pressure.

A new method of soldering glass to metal, developed by GE scientists, makes the bond stronger than the glass itself. The method can also be used to solder metal to ceramics and carbon.

The glass and metal areas to be soldered are painted with a thin layer of titanium hydride, and solder is placed upon both areas. The parts are placed together and then heated under a vacuum.

When the temperature reaches about 900°F the titanium hydride decomposes. This causes the solder, which has already become molten, to adhere to the titanium-painted areas of both the glass and metal. A strong, tight bond is formed upon cooling.

By using soft metal solders, it is possible to subject this glass-to-metal seal to rapid temperature changes without danger of cracking, despite the wide difference in temperature expansions between glass and metal. This is possible because the differences in movement are absorbed by the solder.

photographs by sound

Visitors at G.E's recent petroleum industry electrical show were snapping self-portrait photographs by means of sound.

The photography operation is part of a demonstration of the use of sound tones for remote control by engineers of G. E's Electronics department.

The photographs are taken by using a tone sent out at a certain frequency by a tone generator when the subject-photographer presses a button.

The sound is carried the length of the exhibit booth via a microwave transmitting and receiving unit and is picked up by a selective amplifier attuned only to the particular frequency of the tone.

The amplifier, in turn, produces energy which operates the switch controlling the camera lens and flash attachment.

The entire operation, from the pressing of the button to the clicking of the camera shutter and the flash of the bulb, takes only a fraction of a second.

Engineers said the remote control by tones system can be used in wireless remote control of motors, valves, gates, and doors.

Equipment thus far developed uses a tone generator to produce tones much like notes of a flute. By using combinations of these tones, the equipment can control up to 900 separate operations at distant points.

sawdust for cattle

Sawdust may some day be a practical food for cattle. Experiments conducted show that irradiation with high-voltage electrons, or cathode rays, makes part

(Continued on Page 40)

● There's a K&E slide rule for every purpose. Whether designed to meet the modest needs of the beginner or the exacting requirements of professionals, all K&E rules feature "built in" accuracy and reflect the skill and craftsmanship of America's most experienced slide rule manufacturer.

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Who Is He?

- ☐ *a metallurgist*
- ☐ *an expert toolmaker*
- ☐ *a laboratory technician*

If you checked "toolmaker", you know your way around in a machine shop. He's grinding the contour of a carbide-tipped flat form tool on an optical-type precision grinder equipped with a Norton Diamond Wheel.

Facts You Should Know

One of the reasons for the industrial edge the United States has over other countries is its leadership in the use of cemented tungsten carbide tools. With them, American industry has speeded up mass production.

Cemented carbide tools are so hard that they cannot be machined in their ultimate form by any known metal tool. So, they must be shaped by grinding with abrasive wheels.

Diamond wheels have become the accepted type of abrasive wheel for precision grinding operations on cemented carbides. Their exceptionally fast and cool cutting action and extremely low rate of wear result in economically low grinding costs.

Norton Diamond Wheels

Norton Company pioneered in the development of diamond wheels in this country, bringing out the first Resinoid Bonded Diamond Wheel in 1934. This was followed 5 years later by the durable Metal Bonded Diamond Wheel. And in 1945, came the Vitrified Bonded Diamond Wheel, a development of the Norton research laboratories.

Today, the Norton price list for Diamond Wheels and Hones contains about 1000 items, ranging in list price from $17.70 to $2,877.35, depending on the size of the wheel and the diamond content.

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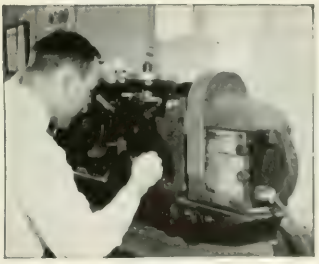
Free Handbook On Grinding Carbide Tools describes in detail how Norton Diamond Wheels are used to recondition and sharpen cemented carbide tools and cutters rapidly and economically. Write for a free copy.



Joseph C. Danec, B. S. Ch.E., Lafayette College '39, examines a diamond wheel section with Bausch & Lomb Research Metallograph in connection with his work on the development of Norton Metal Bonded Diamond Wheels.

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COLD WAR . . .

(Continued from Page 24)

temperatures has been, and still is, a time-consuming operation. Ordinary thermometers are practically useless. Mercury freezes at 39 F below zero, alcohol a little further down. The constant-volume helium gas thermometer, to which corrections are applied to secure conformity to the ideal gas scale, is acceptable all the way down to 1°A. Using this as a fundamental standard, more convenient working thermometers are usually prepared. Vapor pressure thermometers are used wherever possible. Resistance thermometers of platinum, phosphor-bronze, or other metals and thermocouples are also widely used.

For temperatures below 1°A, reliance upon measurements of the magnetic susceptibility of paramagnetic salts is general. It is assumed that for these substances Curie's law is valid. This is: $X=C/T$, where X is the susceptibility and C is a constant. It is possible to correct this arbitrary scale to the thermodynamic scale of temperature when sufficient magnetic and heat capacity data are available.

Low Temperture Phenomena

Perhaps the most fascinating part of low temperature study is the effect of very low temperatures on certain substances. The properties which have been observed to vary with the temperature are the electrical resistance, the magnetic susceptibility, and the specific heat.

The electrical resistance of a large number of metallic elements and alloys falls to zero at very low temperatures. An electric current, once started in a superconducting circuit, continues to flow without help from an electric cell or other source of potential. Once the temperature rises above a critical point, however, the current ceases to flow.

Actually, superconductivity has been put to work in a limited way. This is in a sensitive heat measurer known as a bolometer. This heat-detecting device, built around a superconducting responsive element, can be used to detect heat waves from unseen smoke stacks of warships and from the exhausts of airplanes.

Without a doubt, the most unusual acting element at very low temperatures is helium. At very close to absolute zero, helium exists in two forms, known as helium I and helium II. The second of these has many strange properties, including the ability to separate itself from the first by climbing up and over the walls of the container. This uphill flow has been clocked at 25 *mph*. As yet, there is no theoretical explanation for this apparent defiance of gravity.

The liquid helium of 2°A conducts heat a thousand-fold better than copper does at room temperature. It has the highest thermal conductivity known to man. Liquid helium at this temperature has no viscosity and flows without drag. If one were to stir up some of this liquid helium in a cup, for example, it would continue to swirl around forever (providing it didn't evaporate). For this reason, it is called superfluid.

Practical Applications

As a direct result of the extensive research done in the field of low temperature physics, many practical applications have been developed. For example, research has brought about household refrigeration and the mass production of pure oxygen and nitrogen from liquid air. Liquid oxygen, in turn, is used for oxyacetylene torches and as a constituent of the fuel of V-2 rockets.

Refrigerated crystals, free of internal noise, will pick up radio signals far fainter than the threshold of a heated radio tube.

A tiny rocket motor developed at the cryogenic laboratory of the Ohio State University uses liquid hydrogen as a fuel, and liquid oxygen as the oxidizing agent. Its exhaust jet nozzle emits gases at a speed of around 15,000 *mph*. This vital research may lead to the development of a fuel powerful enough to propel a rocket far out into space.

All in all, low temperature studies have led to better gasoline, stronger steel, longer-wearing rubber, improved glass and more efficient processes in a score of different industries.

How Far Down?

The question that naturally arises at this point is whether the magnetocaloric effect may be used to attain absolute zero. The experimental evidence seems to indicate that it is impossible. In fact, scientists are so sure of this fact, they have based the Third Law of Thermodynamics upon it. It reads: *It is impossible by any procedure, no matter how idealized, to reduce any system to the absolute zero of temperature in a finite number of operations.*

Although most elementary textbooks in physics state that at absolute zero all molecular activity ceases, scientists have found nothing of the kind. Atoms and molecules stop their individualistic operations and instead act like a perfectly drilled chorus. Consequently, one must adopt the following notion: absolute zero is that state of a substance at which it has a minimum of energy, not an entire absence of energy.

Low temperature physics has one characteristic that makes it rather unique, today. The United States and its Western allies readily exchange information with the USSR concerning problems and observations encountered in the low temperature domain. The only "cold war" they fight is the one against Nature.

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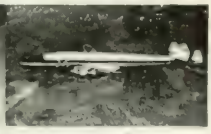
THE F-94—first all-weather jet interceptor assigned to duty with America's aerial defense forces



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SOCIETIES

(Continued from Page 16)

cated at 112 East Daniel in Champaign. Chapter officers for the coming year are Dave Donnelly, president; Ken Walter, vice-president; Gerald Giffin, treasurer; Bob Schrader, corresponding secretary; Harlan Schone, recording secretary; Dick Brown, commissary; and Harold Zahn, house manager. The chapter adviser is Professor L. D. Walker of the GED department.

SIGMA PHI DELTA

"The promotion and advancement of the engineering profession and engineering education; the installing of a great spirit of cooperation among engineering students and their organizations; the inculcation in its members of the highest ideals of Christian manhood, good citizenship, obedience to law, and brotherhood; and the encouragement of excellence in scholarship" is the objective of Sigma Phi fraternity. The motto: "Pro Bono Professionis," which, translated from the Latin, means, "For the Good of the Profession," further bears out the objectives of this International Social Fraternity of Engineers.

Alpha Chapter of Sigma Phi Delta fraternity was founded at the University of Southern California on April 11, 1924, making Sigma Phi Delta one of the youngest of the national fraternities. Delta Chapter of Sigma Phi Delta was established at the University of Illinois on January 25, 1928.

Delta Chapter of Sigma Phi Delta fraternity is located at 1103 West Illinois street, Urbana, Illinois. Members of Sigma Phi Delta may be found in almost all branches of engineering including chemical, architectural and agricultural engineering. Likewise, members of this fraternity may be found in most of the engineering activities, including Engineering Council, *The Technograph*, Sigma Xi, and most of the other engineering societies and honoraries.

The founders of this fraternity combined the functions of all three types of fraternities—honorary, professional, and social, into one fraternity. The social life of the engineering student is limited by the amount of time he has to devote away from his laboratories and theories. Therefore, a social program which tends to make a well-rounded individual, but which does not occupy too much time is the aim of the chapter. The members of Sigma Phi Delta participate in the intramural activities sponsored by the IF Council and support all the other activities and plans of the Council.

Faculty members of Sigma Phi Delta fraternity are Professors Babbitt, Crandell, Knight, Straub, Tuthill, and Wiley. There are also alumni in teaching and research positions on the faculty. Delta Alumni of Sigma Phi Delta has been very active and cooperative in the support of the active chapter. The alumni chapter continues the ties of brotherhood after the members graduate and leave the campus. There are approximately 2000 alumni members of Sigma Phi Delta fraternity throughout the engineering profession.

Walking with a friend one day, a professor passed a large fish shop where a fine catch of codfish with mouths open and eyes staring were arranged in a row. The prof suddenly stopped, looked at them, and clutching his friend by the arm, exclaimed: "Heavens! That reminds me, I have a class in EE this hour."

Drunk: "Loowit that shign."
Drunker: "Whazzit shay?"
Drunk: "Say 'Ladies ready-to-wear clothes'."
Drunker: "Well, ish about time."

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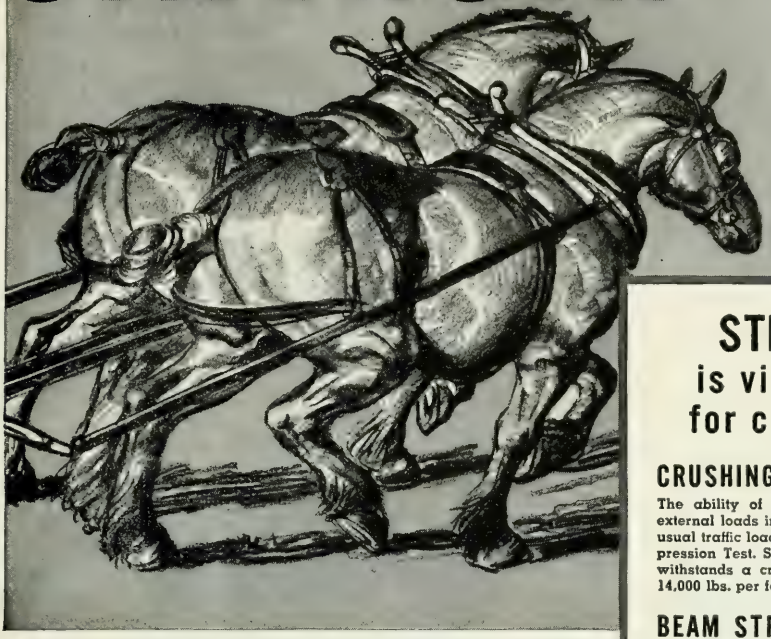
STRENGTH is vital



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When cast iron pipe is subjected to beam stress caused by soil settlement, or disturbance of soil by other utilities, or resting on an obstruction, tests prove that standard 6-inch cast iron pipe in 10-foot span sustains a load of 15,000 lbs.

SHOCK STRENGTH

The toughness of cast iron pipe which enables it to withstand impact and traffic shocks, as well as the hazards in handling, is demonstrated by the Impact Test. While under hydrostatic pressure and the heavy blows from a 50 pound hammer, standard 6-inch cast iron pipe does not crack until the hammer is dropped 6 times *on the same spot* from progressively increased heights of 6 inches.

BURSTING STRENGTH

In full length bursting tests standard 6-inch cast iron pipe withstands more than 2500 lbs. per square inch internal hydrostatic pressure, which proves ample ability to resist water-hammer or unusual working pressures.

Be doubly sure when you specify pipe for mains to be laid under city pavements. Sure that it effectively resists corrosion. Sure, also, that it has the four strength factors, listed opposite, that pipe must have to withstand beam stresses, external loads, traffic shocks and severe working pressures. *No pipe, deficient in any of these strength factors, should ever be laid in paved streets of cities, towns or villages.* Cast iron water and gas mains, laid over a century ago, are serving in the streets of more than 30 cities in North America. These attested service records prove that cast iron pipe not only assures you of effective resistance to corrosion but all of the vital strength factors of long life and economy.

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CAST IRON PIPE SERVES FOR CENTURIES

SKIMMING . . .

Continued from Page 32

of the sawdust digestible by organisms in the cow's stomach. A cow is able to utilize pure cellulose (such as cotton) as food. Wood consists largely of cellulose, combined with another compound, called lignin, in which combination it is indigestible.

The cathode rays make the cellulose available. Bacterial action in the rumen, the first of the cow's four stomachs, is able to convert the cellulose into several other compounds. These can be absorbed in the animal's intestines.

Basswood was used in the experiments, both in the form of sawdust and small waters. A modification of the million-volt-X-ray unit developed by G. E. scientists for medical and industrial use served as a source of electrons.

Ordinarily the stream of electrons, accelerated to million-volt energy in a series of steps, hits a tungsten target at the end of the tube, generating a beam of X-rays. When used for cathode rays, a thin metal window replaced the target and the electrons themselves emerge. Various materials may then be placed in the beam to study the effects.

liquid impact

Ordinary water in which extremely fine abrasive dust is suspended may be used for producing high finishes on both metal and non-metallic products.

Abrasives as fine as talcum powder and even finer are used, suspended in a liquid (usually water and a corrosion preventive) and the liquid is driven against the part to be finished by high pressure air. Impact of the particles removes minute amounts of metal from the surface and leaves it clean and with an attractive appearance.

Actually, the surface after liquid impact blasting is covered with millions of microscopic "pockets." On working surfaces, these hold oil and improve the operation of the part and its life, giving the surface a pleasing, non-glare appearance.

It is also useful on instruments and tools. Cutting tools last longer if they have been liquid-impact blasted. The operation has the same effect as if a machinist carefully honed the cutting surface by hand.

Besides small machines for use in tool rooms, machines have been built to automatically remove heat-treat scale and improve the finish of ring and pinion gears.

Newlyweds.

He: "Who spilled mustard on my waffle?"

She: "Oh, John! How could you? This is lemon pie."

* * *

He: "I suppose you dance."

She: "Oh, yes! I love to."

He: "Fine, that's better than dancing."

* * *

And then there's the fellow who walked into a bar optimistically, and left misty optically.

* * *

I serve a purpose in this school
On which no man can frown—
I quietly sit in every class
And keep the average down.

* * *

Freshman: "I have a sliver in my finger."

Sophomore: "Been scratching your head?"

* * *

Professor: ". . . and that concludes my lecture. Now everybody poke his neighbor so that the sound of the bell won't shock him!"

* * *

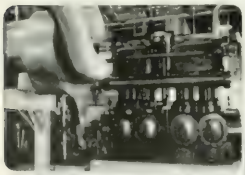
Jungle love is where a couple just monkey around.

Buffalo's Largest Store Air Conditioned throughout with Frick Refrigeration

All Departments are Air Conditioned

Sattler's Department Store, covering most of a large city block, serves up to 150,000 people in a single day. The giant store is cooled in hot weather with ten Frick ammonia compressors using 920 horsepower. Installation by Mollenberg-Betz Machine Company, Frick Sales Representatives at Buffalo, N. Y.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.



Ten Frick Compressors Installed on the Roof of Sattler's Store at Buffalo

DEPENDABLE REFRIGERATION SINCE 1853
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LUFKIN CHROME-CLAD STEEL TAPES . . . FIRST CHOICE OF STUDENT AND GRADUATE ENGINEERS

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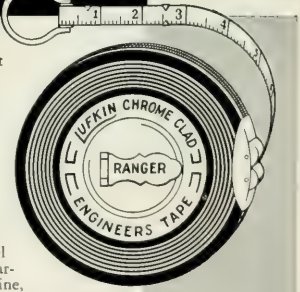

Whether for use scholastically or on the most important engineering project of your career, you cannot select a finer "Engineers" Tape than the Chrome-Clad "Ranger". Permanent, easy-to-read black markings stand out sharply against the chrome white background—the finish that will not crack, chip, peel or corrode. Sturdy, quarter-inch wide flexible line, with "Instantaneous Readings" is enclosed in a genuine leather case. In 50 and 100-ft. lengths, marked feet, 10ths and 100ths; or feet, inches and 8ths. See the "Ranger" at your Technical Supply House.

RANGER

136

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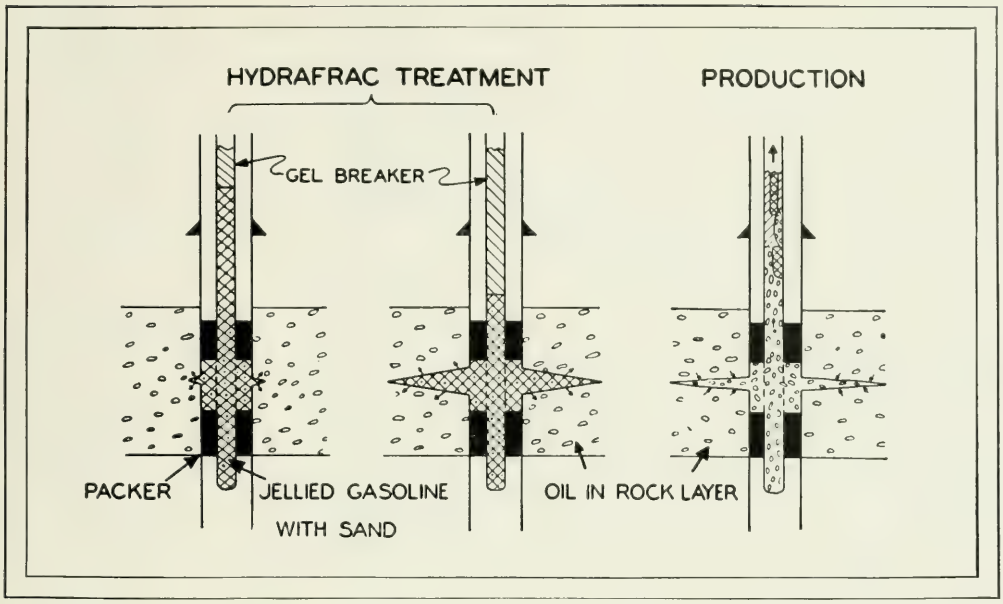


How "Jellied Gasoline" puts played-out oil wells back on their feet

THE PROBLEM of "rejuvenating" wells has become more and more urgent as tremendous civilian and military demands for petroleum products have continued to mount. A new hydraulic fracturing method has now passed the test of use on more than 3,000 wells in the field as the best way to get more oil from sources that have stopped producing.

Essentially, the new "Hydrafrac" method consists of two steps. First, a viscous liquid containing sand, or other granular material, is injected into the well under high hydraulic pressure. This causes fractures, or extends fractures, from the well bore into the oil-bearing formation.

Second, the viscous liquid—usually crude oil or kerosene and Napalm, the newly developed soap which was used in the war to make "jellied gasoline"—is broken down by injecting a gel-breaker solution. On release of the injection pressure, the resulting thinner solution flows back out of the fracture, now extended and widened, leaving the sand behind to hold the channel open for flow of oil into the well.

The Stanolind Oil and Gas Company of Tulsa, Oklahoma, Standard Oil's principal producing subsidiary, developed the Hydrafrac process after tackling the problem of "milking" old wells.

The process has been used both to obtain sustained production increases on "dried up" wells and to get a commercially practical flow from "tight" oil-saturated formations. Hydrafrac is now available, as a service, to the entire industry, helping it reach the higher and higher production goals of today.

This is an example of the interesting problems young engineers at Standard Oil face. And satisfaction in its solution is another instance of the rewards that come to the man whose research helps Standard Oil meet America's vitally important civilian and preparedness needs.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

THEMES . . .

Continued from Page 281

which might be valuable to a civil engineer. I doubt whether there is any kind of a job that doesn't offer some possibilities for learning. One thing of interest that I noticed was what could become of the engineer's work in the hands of the workmen. There must be thousands of blueprints drawn up every year only to be cast aside while the foreman does the work as he thinks it ought to be done. I worked for an old foreman who had been on the same job for the last twenty-five years. We were supposed to lay out a new high-speed curve. We had all the materials, including rolls and rolls of blueprints. I don't believe the old boy looked at them once. We laid out the curve under his direction and the trains seemed to run over it all right. Whether they would have run better if he had followed the blueprints I don't know, but it gave me something to think about anyway.

There is also a difference between what you read in the textbooks, and what actually happens on the job. For instance, the textbook tells you that the ties are tamped, dressed, and they carry such and such a load. Actually, though, the quality of a railroad bed is dependent on the skill and persistence of the men tamping the ballast under the ties. I've seen two pairs of men tamping alternate series of ties, one pair tamping solidly and the other pair just covering up the whole so it would look good. This undobutedly gave the worst riding track possible.

Probably the most important thing that anyone learns through working on the job is the worker's outlook. No man could be a successful supervisor without having a little insight into the worker's psychology. I learned things about the Taft-Hartley Law on the road that I'm sure would be a great surprise to Senator Taft himself. Likewise I learned what makes men like one supervisor while they think another is "chicken."

All things considered, I guess the summer wasn't wasted—I earned a little money (not much), I got some nice, tough callouses, and I learned the big difference between theory and practice. But my real finding; the gem; the little golden drop of distilled wisdom which I extracted from my summer's work with pick and shovel was this: Get yourself some nice job in an air-conditioned office as far from the digging as possible, thinking up ways of putting wings on the freight trains so they won't need tracks to run on anyway.

"In some parts of India a wife can be bought for $2. Isn't that awful!"

"Oh, I don't know; a good wife may be worth it."

* * *

Student: "I don't like these pictures, they don't do me justice."

Photographer: "Justice—son, what you need is mercy!"

* * *

Jill: "Got something in your eye?"

Jack: "No. I'm just practicing looking through my thumb."

* * *

The E.E. truly spoke when he said: "Electricity travels 11,600,000 miles a minute, arriving just 59 seconds after the town gossip."

* * *

Freshman German Student: "What is castor oil known as in Holland?"

Senior: "Old Dutch Cleanser."

* * *

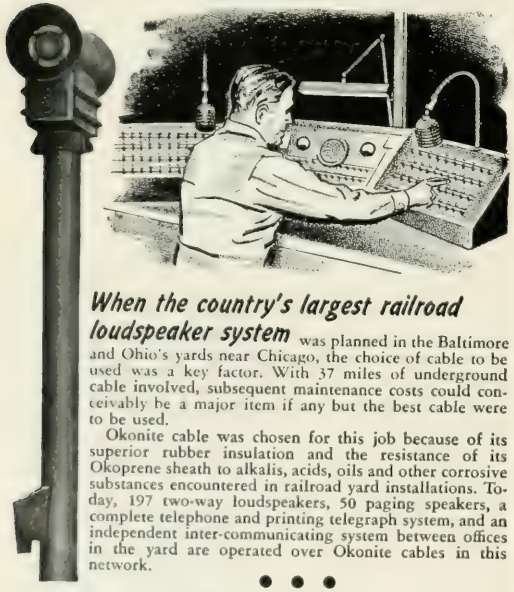
What this world needs is a transparent eight-ball so we can see where we are going."

* * *

Overheard in the testing lab:

"Did you say your girl's legs are without equal?"

"No, I said they knew no parallel."



When the country's largest railroad loudspeaker system was planned in the Baltimore and Ohio's yards near Chicago, the choice of cable to be used was a key factor. With 37 miles of underground cable involved, subsequent maintenance costs could conceivably be a major item if any but the best cable were to be used.

Okonite cable was chosen for this job because of its superior rubber insulation and the resistance of its Okoprene sheath to alkalis, acids, oils and other corrosive substances encountered in railroad yard installations. Today, 197 two-way loudspeakers, 50 paging speakers, a complete telephone and printing telegraph system, and an independent inter-communicating system between offices in the yard are operated over Okonite cables in this network.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE *insulated wires and cables*

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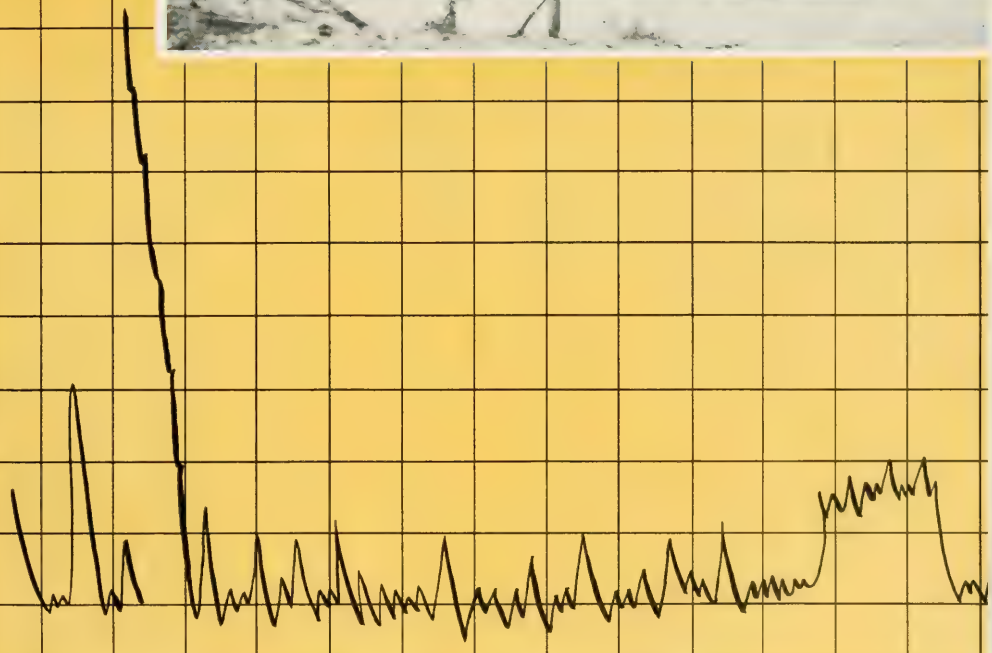


the **illinois technograph**

ember
c. m. a.

november, 1951

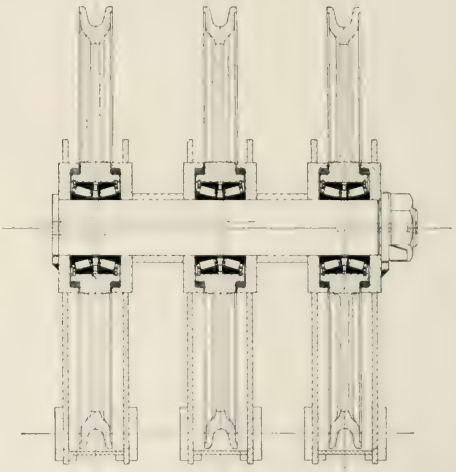
Another page for **YOUR BEARING NOTEBOOK**

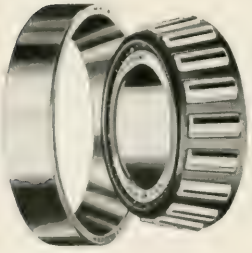
How to buck up a bucket

To carry the tremendous load on the sheaves of this giant, 17-ton-capacity clamshell, engineers mount them on Timken® tapered roller bearings. Due to line contact between rollers and races, Timken bearings have unusual load-carrying capacity. And because of their tapered construction, they take radial and thrust loads in any combination. Friction is practically eliminated. Lubrication is kept to a minimum because Timken bearings permit effective closures to keep dirt and water out and retain lubricants longer.

Mounting sheave bearings

The Timken bearings in this application are mounted with slotted cone spacers to provide lubrication through the shaft. The entire sheave assembly is clamped together by means of a nut and spacers between each bearing assembly. Felt seals are used. Cups are mounted with a press fit in the sheave hubs and positioned with snap rings.





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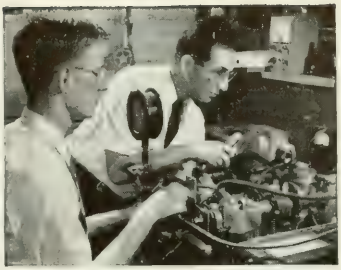
How you can learn more about bearings

Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For additional information about Timken bearings and how engineers use them, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST —◎— LOADS OR ANY COMBINATION ✳

THE DU PONT DIGEST



Albert Rand, *B.S.M.E., M.I.T. '50 (right), and Rane Curl, M.I.T. '51 (summer worker), develop controls for chemical equipment.*

M.E.'s AT DU PONT [2]

Challenging variety of problems solved by research and development engineers

As a student of mechanical engineering, do you look forward to a future in research, development, plant engineering or production supervision?

In the *Digest* this month, we'd like to discuss the ample outlet Du Pont offers your talents in these fields.

Let's talk about research and development together because they often overlap indistinguishably. Both these fields deal with mechanisms for making products. In some cases, original equipment is designed for a new product. In others, machinery used in making existing products is improved to provide better quality at lower cost.

This design and development work may call for studies of the vibration of machine elements, equipment, structural members and structures. Or there may be need for application of electronics, instrumentation, operation of test equipment and testing of experimental machines. In much of this activity there is close cooperation with other engineers, participation in group conferences, joint analysis of data, and issuance of recommendations.

J. D. McHugh, *B.S.M.E., Rochester '50 (center), consults with D. B. Berlien, B.S.M.E., Purdue '56 (right), and J. F. Crawley, Jr., M.S.Ch.E. '47, V.P.I., on installation of equipment in the field.*

Du Pont research and development engineers keep informed of developments through technical, trade and patent literature, seminars and lectures. Exceptional facilities for these are provided.

Here are some examples, specific and general, of the problems that confront Du Pont research and development engineers:

1. Develop and design high-speed slitting equipment for thin films. Involved are unwind and wind-up tension regulation, alignment of web travel and cutting-knife selection, combined in a machine easy to service.

2. Design equipment to operate at pressures up to 45,000 p.s.i. This is insurance against the time when processes may be developed that will operate in this range.

As pressures are increased, design problems for moderate pressures are magnified. Typical are stress-fatigue of metals, design of vessel closures and line joints, valves and packing for reciprocating compressors and centrifugal pumps, packing glands for stirred autoclaves, etc.

3. Design, installation and testing of large air-conditioning systems necessary in the manufacture of certain products. In one plant, water is used at the rate of 50 million gallons daily, current at 25,000 kw. per hour, and air at 5.5 million C.F.M.

These three examples, selected from literally hundreds, can only hint at the breadth and variety of the problems that are constantly arising.

R. T. Bradshaw, *B.S.M.E. '46, M.S. '47, Queens U., Ireland, and J.D. McHugh, B.S. M.E., check theoretical calculations.*

One of the strongest pieces of evidence that mechanical engineering is of major significance in the Du Pont Company is the existence of the Wilmington Shops. They represent an investment of over $3,500,000 and cover an area of 300,000 sq. ft., including a foundry and pattern shop. They employ over 800 men and have a potential output in volume of work in excess of $6,000,000 a year.

The size and diversity of this operation are justified only because the work of mechanical engineers is an important factor in Du Pont operations.

NEXT MONTH—*Opportunities in plant engineering and product supervision will be discussed in the third article in this series, "M.E.'s at Du Pont." Watch for it!*

Send for your copy of "The Du Pont Company and the College Graduate." Describes opportunities for men and women with many types of training. Address: 2521 Nemours Building, Wilmington, Delaware.

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"Nobody grows old by merely living a number of years; people grow old only by deserting their ideals. Years wrinkle the skin, but the giving up of enthusiasm wrinkles the soul. Worry, doubt, self-distrust, fear and despair—these are the long, long years that bow the head and turn the growing spirit back to dust.

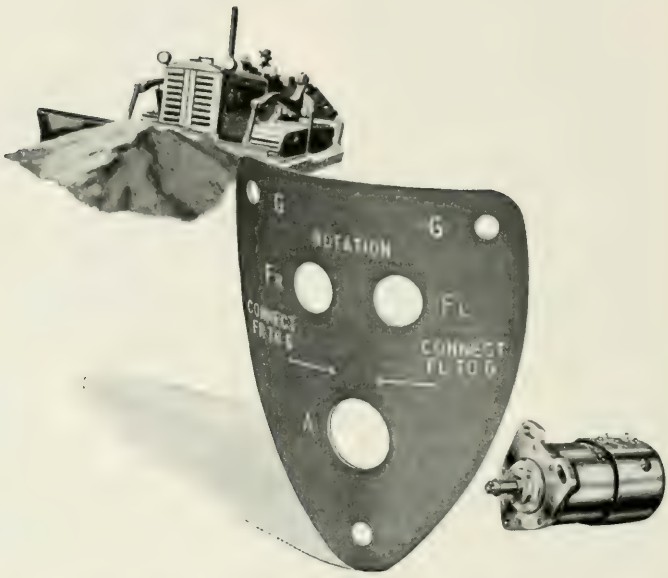
"Whether seventy or sixteen, there is in every person's heart the love of wonder, the sweet amazement at the stars and star-like things and thoughts, the undaunted challenge of events, the unfailing child-like appetite for what next, and joy in the game of life.

"You are as young as your faith, as old as your doubt; as young as your self-confidence, as old as your fear; as young as your hope, as old as your despair.

"So long as your heart receives messages of beauty, cheer, courage, grandeur and power from the earth, from Man and from the Infinite, so long you are young.

"When the wires are all down and all the central place of your heart is covered with the snows of pessimism and the ice of cynicism, then, certainly, you are grown old indeed!"

—from a framed message which hung over the desk of General MacArthur in his Manila Headquarters.



How to move mountains—non-stop

When it comes to moving mountains—or spreading the landscape around—you can't beat bulldozers.

You can, however, beat a bulldozer if you put into it a part that can't stand the gaff.

An example is the generator. Vibration, abrasive dust, weather, shifting stresses and stray oils or greases are constantly taking their hardest licks at it. It leads a tough life.

That's why American Bosch Corporation, makers of dust-proof, heavy-duty generators for industrial tractors and bulldozers, selected Synthane laminated plastics for the insulation plate shown above.

Synthane is a material for industry. It possesses an unusual *combination* of physical, mechanical, chemical and electrical properties.

Synthane is light, strong, dense, abrasion resistant. It is easily machined or produced in formed shapes. Dielectrically strong, it is a natural for electrical applications. Synthane is corrosion and fungus resistant, chemically inert, stable over a considerable temperature range.

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the illinois technograph

volume 67 number 2

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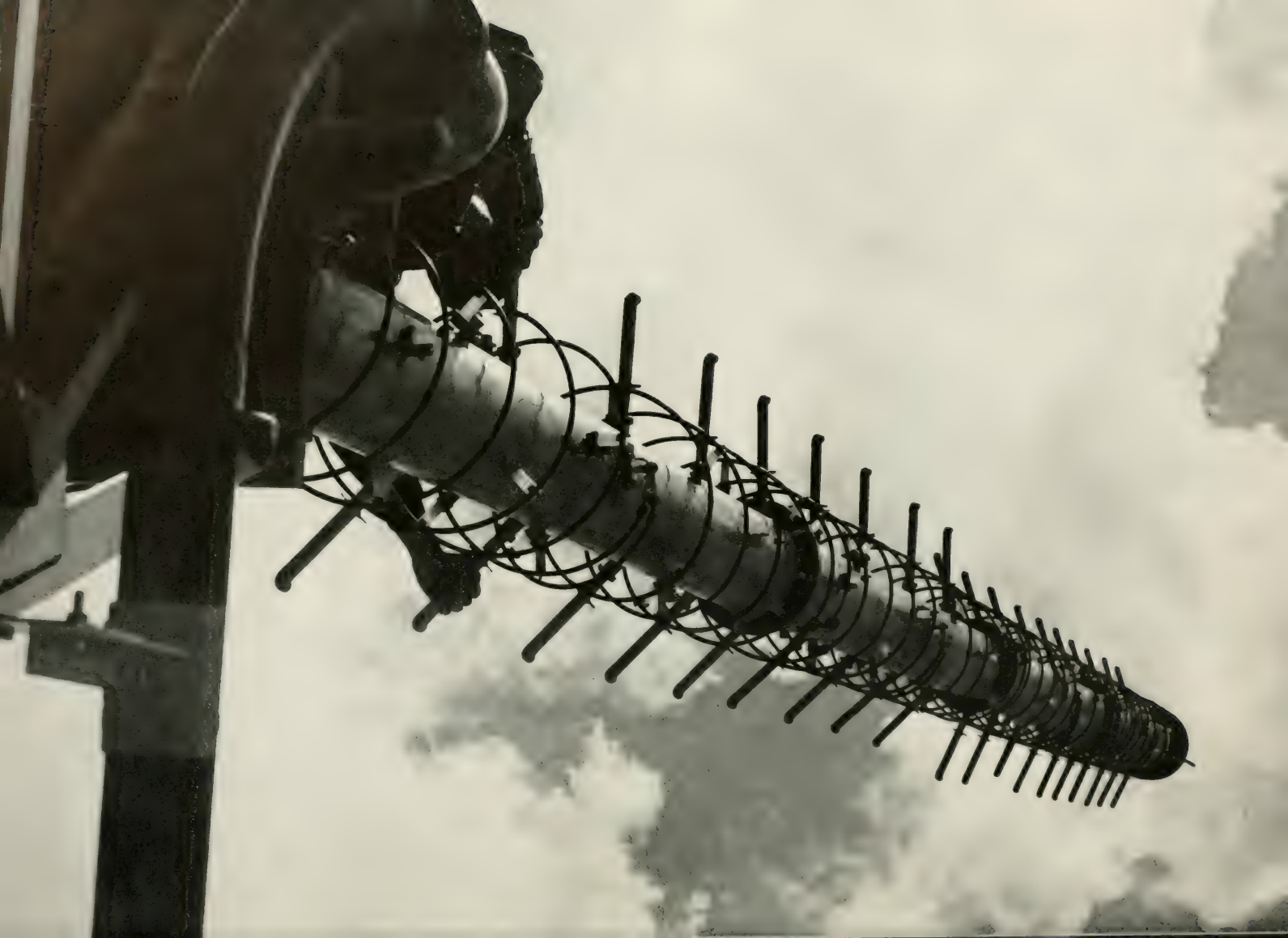
our cover

A "fantastic weapan" is on its way at the Air Force's Missile Test Center in Cocoa, Fla. A U. S. Air Force Martin B-61 Matador pilotless bomber takes off with the roar, black smoke, and white heat of its rocket auxiliary thrust. (Courtesy of Glenn L. Martin Co.)

our frontispiece

This radically different type of television antenna is known as an "helical" antenna. Developed by G E engineers, it increases initial transmitting power 20 times and is being used in ultra-high-frequency TV transmission. (Courtesy of General Electric).



the technograph reviews the conference on . . .

water resources

edited by Henry Spies, ag.e. '52

The Illinois State Water Survey Division dedicated its new $490,000 laboratory and office building in conjunction with a 3-day conference on water resources sponsored by the division and held at the University of Illinois on the campus at Urbana-Champaign, October 1, 2, and 3.

The Conference was divided into three sections, hydrology, chemistry of water treatment, and weather-radar, the

Entrance to the new Water Resources building.

sessions in all three sections running concurrently. The hydrology sessions were held in the Illini Union Building, the treatment sessions in the new East Chemistry Building, and the weather-radar conference at the Robert Allerton Estate.

The objectives of the conference were a better understanding of the development and use of fundamentals in water resource design and planning, and the orientation of collection of basic information. To this end over 70 scientists presented papers at the 3-day meeting.

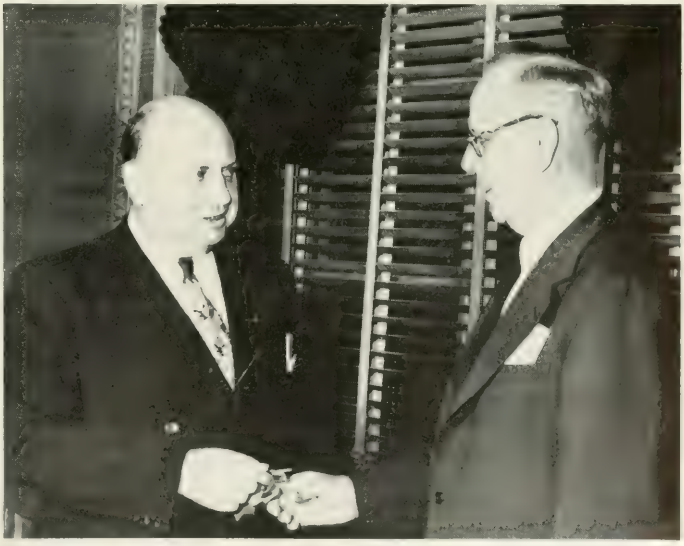
Albert S. Fry, Chief Engineer, Hydraulic Data Branch, T.V.A., Knoxville, Tenn., spoke on "Hydrology and the Hydraulic Laboratory." Fry discussed the typical laboratory and listed some of their functions as the development and construction of devices and equipment, rating and calibrating hydrologic instruments, and the working of hydrologic problems by the isolation of variables that is not possible under natural conditions. It was emphasized that more attention should be given to the transition from laboratory conditions to field conditions, such as variable slopes and the change from prismatic channels to river channels. This discussion indicated a number of ways in which the Water Survey's new hydraulic laboratory could be used to solve many of Illinois' water resources problems.

Hans A. Einstein, associate professor of mechanical engineering, University of California, Berkeley, California, spoke on "Bed Load Function for Sediment Transportation in Open Channel Flow." Einstein, son of the famous Albert Einstein and himself an authority in the field of mechanical engineering, discussed the problems of measuring sediment transport in streams. He indicated that the ability to carry sediment depends upon the flow in the channel, and that the values for Cutter's "n" vary according to velocity. Results of his work indicate the sediment transport itself does not have frictional effect on the bed, but rather the friction is the sum of the friction among grains and friction due to irregularities of the stream bed.

Lest it might seem that this was too highly technical a subject to discuss at such a conference, Professor Powell quoted the rhyme of "There's a family known as Stein, there's Gert, and there's Epp and there's Ein. Gert's poems are bunk, Epp's statues are junk, and nobody understands Ein." As Powell pointed out the poem was written with Albert Einstein in mind and he wished to show that it certainly didn't apply in the case of his son Hans.

At the Tuesday session on "Sedimentation Problems" a paper by O. W. Chinn, Director, Division of Flood Control and Water Use, Department of Conservation, Frankfort, Kentucky, was given considerable attention. Chinn asked for the stream lining of flood control and sediment control programs to be financed chiefly through federal funds but carried out with close state

(*continued on page 26*)



Henning Larsen accepts the key to the Water Resources building from C. Hobart Engle during the three-day conference on water resources.

$$Z_{A1} = \frac{\rho c}{S_1}\left[\frac{jZ_{A2}\,\frac{\sin k(l-\theta_2)}{\sin k\theta_2} + \frac{\rho c}{S_2}\sin kl}{Z_{A2}\,\frac{\sin k(l+\theta_1-\theta_2)}{\sin k\theta_1 \sin k\theta_2} - \frac{j\rho c}{S_2}\,\frac{\sin k(l+\theta_1)}{\sin k\theta_1}}\right]$$

This little mouthful expressing the throat impedance of a finite conical horn radiator represents one of the many equations someone had to evaluate in designing, for instance, the little resistant sound projectors gracing the front fenders of the University police squad cars. It also represents the first and last mathematical expression in this article. In the following abbreviated description of the design and operation of a loudspeaker, the writer, in lieu of a rigorously developed exposition of electro-acoustical theory relating to design problems and experimentally-derived data concerning operation, will confine himself to expressing opinions which appear to be those most widely accepted by the professional talent enjoying the reputation of being the most competent in the field. Before proceeding, however, a note of apology may be in order. If it appears that the writer sometimes shows a little bias, or is violently prejudiced against some present-day audio practices, or displays a predilection for improved audio reproduction for the masses—then, the reader is to be commended upon his perceptual acumen. The writer pleads guilty to all charges.

A loudspeaker, to begin with, is a device which takes electrical energy from the power output stage of an amplifier, and, after suitable transformation, converts this energy to acoustic energy which is released or radiated to the surrounding air. There are two types of loudspeakers in general use at the present time: the horn type loudspeaker, and the diaphragm, or direct radiator loudspeaker (of which type shall be considered only the moving-coil, or dynamic, loudspeaker, since the others are either obsolete, obsolescent, or impractical). Essentially, the two are identical electrically. The difference lies in the method of coupling the moving diaphragm to the air. The direct radiator type has the diaphragm directly exposed to the free air, whereas the horn type utilizes a column of air confined to an enclosure whose dimensions are determined by acoustic theory. For the following paragraphs relating to design and operation, the direct radiator will be considered as representative of both types, and the horn itself will be treated later in the section dealing with baffles.

The diaphragm type loudspeaker consists of five main parts: the frame, the cone, the spider, the voice coil and the magnetic structure. The frame is a skeletal, metallic member of pressed or cast fabrication, resembling the frustum of a cone, to whose outer periphery is mounted, by a suitably complaint ring of soft material, the outer edge of a truncated paper cone. The inner extremities of the frusta are joined by a highly compliant member, the spider, serving the dual purpose of restraining the cone to the extent that the excursions shall be symmetrical about the quiescent position, and retaining the voice coil, affixed to the inner edge of the cone, in a position concentric to the center pole of the magnetic structure, which is fastened to the inner end of the frame. This magnetic structure is an assembly consisting of a magnet—either a permanent magnet, as is very prevalent in modern practice, or an electromagnet, as was customary in pre-war years — and associated parts forming a complete path for the magnetic flux. Quite often this assembly takes the form of a cylindrical magnet reposing in a metal "pot" in such fashion that the longitudinal axes are collinear and concurrent. The open end of the "pot" is fabricated with a lip, forming, with the pole-piece, an annular gap, thru which is channeled the flux field, and in which is disposed the voice coil.

Excitation of the voice coil by the electrical energy from the amplifier output transformer causes the voice coil to oscillate, parallel to the longitudinal axis, in the annular gap in a direct mechanical counterpart of the electrical energy variations. Since the voice coil is rigidly fastened to the cone (except for certain special types which will be specifically handled later), the vibratory motion is transmitted to the cone, and it is thus constrained to follow suit. It is readily apparent that the periodic excursions of the cone will give rise to successive compressions and rarefactions in the surrounding medium, air. These successive compressions and rarefactions constitute an accoustic phenomenon familiar to everyone—a sound wave.

The foregoing represents an ideal picture of what transpires in a loudspeaker in operation. Unfortunately, the problem of causing a loudspeaker to generate acoustic power that is a faithful counterpart of the impressed electrical power is by no means simple. It represents the singular anomaly of "sending a boy to do a man's job." Frequency response, power-handling ability, efficiency, and distortion introducing characteristics all require consideration and, quite often, the demands are entirely contradictory.

In the case of loudspeakers primarily intended for speech reproduction and/or reinforcement, the problem is not so difficult, since the requirements are not as severe as in the case where reproduction of music is the primary consideration. Speakers for the former purpose have been designed and are available at very reasonable prices. For this reason, among others, speech considerations will not be dealt with here.

BOB QUICK

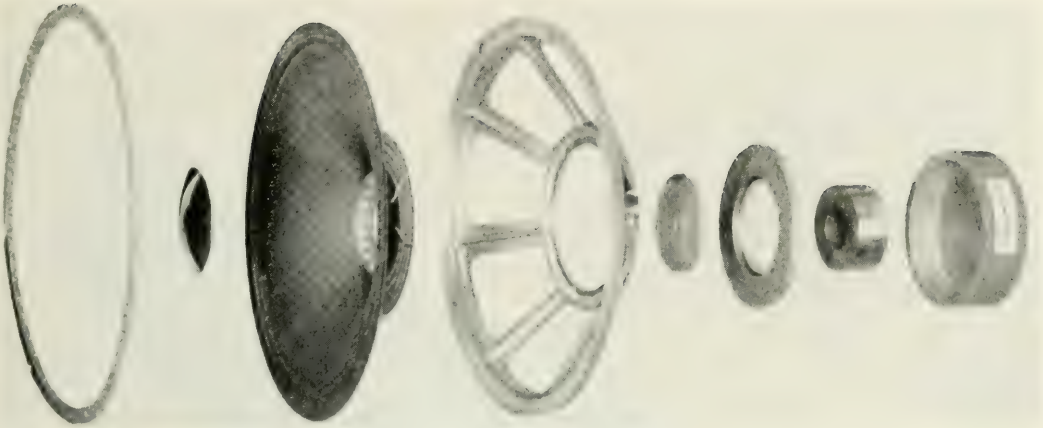
Bob's acquaintance with loud speakers is not a purely academic one. From 1945 to 1948, he served as a radio technician in the Signal Corps. Bob also worked for Western Electric, Motorola, and Hallicrafters.

Entering the U. of I. in Sept., 1950, he is now a sophomore in engineering physics. At present, Bob is considering computing machine design as a future career.

Besides his duties on the Tech, Bob is a member of Phi Eta Sigma.

from electrical energy to acoustic energy . . .

behind the



Components of the loudspeaker (l. to r.): flexible surround joining cone and frame; curved, metallic diaphragm closing front end of voice coil, voice coil and spider; the frame; and four pieces comprising the magnetic structure: the center pole, the "pot lip," the magnet, and the "pot." (Courtesy of High-Fidelity).

grill cloth

by Bob Quick, e.ph. '54

For the speaker called upon to reproduce music of a quality comparable to that of the original, the problem becomes exceedingly complex and has not yet been satisfactorily solved. In order to reproduce music, the speaker must, obviously, be capable of generating sound waves over the frequency spectrum containing the original sounds. Without going into great detail, and without including a long list of source material, it will be stated that the extreme limit of the audible spectrum under favorable conditions extends from 16 to 22,000 *cps*. It has been shown that a reproduced range of 40 to 15,000 *cps* in average circumstances is more than satisfactory, and a range from 60 to 10,000 *cps* adequate for most persons. For the discriminating listener, in favorable surroundings, the maximum range is desirable, but not yet absolutely necessary, since there is very little in the way of source material which requires response between the limits of, say 20 to 20,000 *cps*. The speaker must not discriminate against any of these frequencies nor must it introduce any spurious reinforcements, arising usually, from resonances and harmonics thereof due to the natural period of vibration of any or all of the motional parts of the speaker and, sometimes, the frame, when economic considerations have dictated a very light, insufficiently rigid construction.

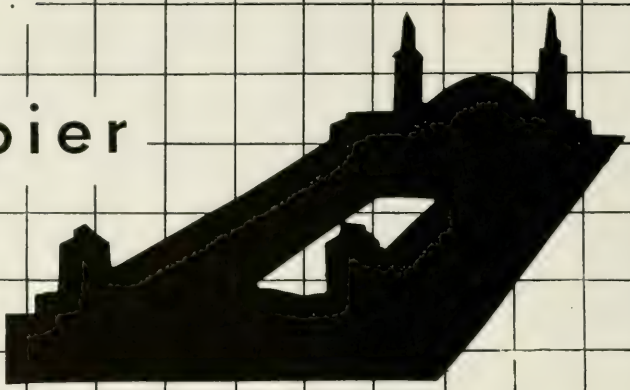
Power handling capacity of the speaker is governed by the strength, and therefore, the weight of the cone, the heat dissipating ability of the voice coil, and the size of the magnet. If the cone is made strong enough to withstand extreme excursions or rapid rise-time transients, it will be too heavy and too stiff to properly reproduce the high frequencies. This difficulty has been partially surmounted by two methods: one consists of fabricating the cone from concentric rings of material possessing different compliances, thus presenting a decreasing stiffness gradient to the vibrations emanating from the voice coil, whereas the other method involves experimental determination of the exact location and the frequencies at which cone "breakups" occur (the point at which the cone develops localized nodal vibrations, a common and serious cause of distortion), and then treating the cone to vary its compliance. This treatment may consist of forming annular, concentric corrugations in the proper regions, or chemically or mechanically causing the paper structure to assume a new compliance.

The voice coil must be heavily built to dissipate sufficient power at low frequencies, and very light in weight to vibrate at high frequencies. There are two methods which have been devised to fulfill these diametrically opposite conditions: separate speaker elements for different parts of the spectrum (this will be discussed in a following paragraph), and a rather tricky form of voice coil construction wherein the voice coil is formed of sufficiently heavy wire wound upon a dural or aluminum tube, or former, and separated therefrom by either a thin, elastic sleeve or a layer of plastic cement. The former is closed at the forward end by a metallic cap or diaphragm, usually curved (since a curved sound source exhibits satisfactory directional characteristics except in the region of the frequency spectrum for which its dimension is one wavelength).

(*continued on page 20*)

— *the university of illinois at . . .*

navy pier



by Warren H. Brandt, c.e. '54

At an impressive ceremony attended by 300 engineers, members of the faculty, and railroad officials, the Illinois Central Railroad presented to the Chicago Undergraduate Division an historic locomotive bell which had been used to celebrate the centennial of the railroad.

Officiating at the presentation were Frederick W. Trezise, associate dean of the college of engineering for the University and Wayne A. Johnston, president of the Illinois Central and member of the University's board of trustees.

The proceedings opened with the singing by the University choir of "Tramp, Tramp, Tramp" by Herbert and followed with "I've Been Working on the Railroad" in which the audience enthusiastically participated.

Dean Trezise extended a cordial welcome to the guests from the Illinois Central and noted the significance of the Undergraduate Division's location in the same city with the offices of the railroad. Dean Charles C. Caveny of UIC also welcomed the railroad's staff and introduced their vice president and chief engineer, C. H. Mottier.

Mr. Mottier's comments were particularly interesting in that he introduced Illini graduates that hold responsible positions with the railroad's engineering department. These gentlemen, ten in number, were seated on the platform with Mr. Mottier and the audience warmly applauded them.

Following Mr. Mottier, Dean Trezise introduced the principal speaker, Mr. Johnston.

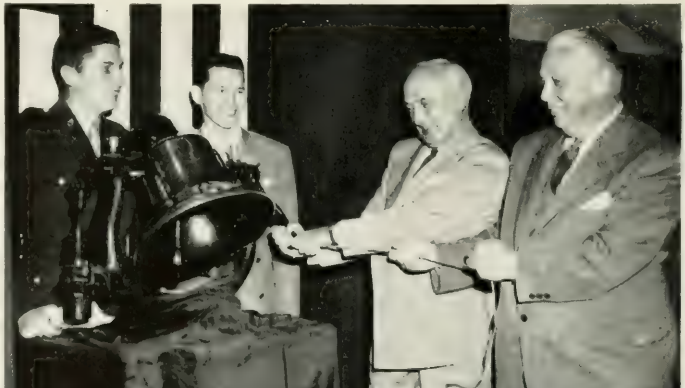
Mr. Johnston outlined the railroad's one-hundred year history and noted how it, from the very outset had cooperated with the University. He explained how, when the University was established in 1867, the Illinois Central was influential in securing the site of the new college at a station on its line. This was accomplished by an offer of the railroad to haul, free of charge, construction materials for the school for a period of six months.

Through the years, the railroad and the University have cooperated with one another to their mutual benefit. The work of the University's Engineering Experiment Station in the testing of rails and other car and track appliances is especially noteworthy. In turn, the railroad has furnished for the use of the mechanical engineering school, a locomotive on which various tests are performed. The joint railroad-University Dynamometer Car is another example of this cooperation.

Nor does this cooperation cease with the furnishing of technical information, Mr. Johnston noted that the railroad has always looked to Illinois as a source of manpower for the managerial positions on the vast transportation system.

At this point Mr. Johnston formally

(*continued on page 24*)



Harry D. Newman and Henry M. Musal look on while Dean Trezise and President Johnston ring the centennial bell in their honor.

what are the odds when you . . .

take a chance

by Bob Dreshfield, met.e. '55

During the course of a day everyone uses odds. A person may look at a dark, cloudy sky and say that it looks like rain. From past experience, he knows that when the sky is dark and cloudy rain usually follows. A man leaves his house and sees a bus at the corner. He knows that if he doesn't run, he will probably miss the bus. If the Weston football team beat Easton and Easton beat North High, Weston will probably defeat North High. The above are all examples of intuitive probability.

It has been said, "The race is not always to the swift, nor the battle to the strong." This adage is usually followed by ". . . . but that is the way to bet." We follow simple logic when we bet on a favorite.

A person familiar with geography can say with confidence, that on the Fourth of July it is more likely to rain in Seattle than in Death Valley. He could also say that a freeze is more probable in Sitka than in Miami on New Year's Day. A man with no knowledge of the location of the above places would have no basis on which to make those statements.

It would be quite safe to say that Mr. Doe, a man of eighty, will precede his grandson of eighteen to the grave. This is knowledge because we are accustomed to seeing elderly people die before younger ones do.

Additional information plays an important part in intuitive calculations of probability. If one man with a car is to race another man with a plane, the man with the plane would be expected to win. However, if the plane's gas tank were partially filled with water, it would not be surprising to see the automobile win the race. In similar fashion, if Mr. Doe's grandson were on the front line in Korea, the youngster's chance of outliving his grandfather would be considerably lessened.

To determine the probability of an event intelligently, one must know all the pertinent facts. In the above cases, the probability was determined by intuitive reasoning. There is another large class of probabilities which can be calculated by simple mathematics.

One who has never seen a coin before could reason that it has equal chances of falling heads or tails. In like manner one could reason that the chances of drawing the ace of spades from a deck of cards is one in fifty-two. It should be equally obvious that when a die is rolled, there is one chance in six of a two showing on top.

In stating probability, for the most part, the words *likely* and *unlikely* are not specific enough. If one were offered twenty to one odds that he could roll "snake-eyes" in one throw of the dice, he would like to know his exact chances. (He probably wouldn't take that one because the odds are thirty-five to one against him.)

BOB DRESHFIELD

Although it might appear that Bob was interested in math, his interest in odds was developed soon after coming out on the short end of a poker game.

Born in Boston, Mass., Bob is now a freshman in metallurgical engineering. After graduation, he intends to get a M.S. and eventually end up doing sales work in his chosen profession.

There are two methods used for expressing probability. If an event must occur, it has a chance of one. If it cannot occur, it has a chance of zero. All other cases are expressed by fractions less than one. In expressing the chance of an event, one shows the number of favorable cases as compared with the total number of cases. Any probability can be expressed as a fraction in the following manner:

$$\frac{\text{number of favorable events}}{\text{number of favorable events plus number of unfavorable}}$$

or:

$$\frac{\text{favorable events}}{\text{total number of events}}$$

Let us look at the coin problem again. There is one head and one tail. What are the chances of tossing tails? There is one favorable case and one unfavorable case. The fraction could be:

$$1/1+1 \quad \text{or} \quad 1/2$$

The second way to express probability is to say that the odds are three to one for the event. This is an expression of the number of favorable cases to the number of unfavorable ones. The odds of rolling a two with one die would be one to five. In the preceding example, it is easy to see that the probability would be shown by the following fraction:

$$1/5+1 \quad \text{or} \quad 1/6$$

To be able to calculate the number of favorable or unfavorable events for a problem, a knowledge of the permutation and combination formulas is necessary. The combination formula is expressed by nC^r where n is the number of events and r is the number taken at a time. To solve the formula, one substitutes values in the fraction:

$$\frac{n(n-1)(n-2)\ldots(n-r+1)}{r(r-1)(r-2)\ldots(3)(2)(1)}$$

For example, how many five card poker hands are there? There are fifty-two cards taken five at a time. The formula would be $52C^5$ and would be solved by the fraction:

$$\frac{(52)(51)(50)(49)(48)}{(5)(4)(3)(2)(1)} = 2,598,960$$

The permutation formula deals with arrangements. It is expressed as nP^r. N is the number of events taken and r is the number taken at a time. The expression is solved by substituting values in the following:

$$n(n-1)\ (n-2)\ \ldots\ldots(n-r+1).$$

How many arrangements are there of the numbers between one and five if they are taken four at a time? The calculations are:

$$(5)(4)(3)(2) = 120$$

An example involving more than one method is to find the probability of being dealt a royal straight flush. By intuition one knows that there are four such flushes, one in each suit. The number of favorable cases is four. The total number of cases is found by solving nC^r where n is fifty-two and r is five. The fraction would be:

$$4/2,598,960$$

Odds influence us every day from birth until death. At birth there is the chance of living. When we cross a street, the chance of being hit by a car makes us cross with the lights. Although one may beat the odds for a while, eventually they will even out. Because one cannot escape the influence of odds, he should know how to calculate them.

introducing . . .

by John Huber, ag.e. '52 and Don Sweet, e.e. '53

PROF. RUDOLPH G. WUERKER

When Professor R. G. Wuerker joined the faculty of the department of mining and metallurgical engineering in 1949, he had a career behind him that had taken him all around the globe. His profession as a mining engineer and the fact that he had to leave his native country in 1934, when Mr. Hitler came to power, are the reasons for this travel.

Rudolph G. Wuerker, assistant professor of mining engineering, was born in 1902, received his B.Sc. and E.M. degrees at the Technische Hochschule, Berlin—Charlottenburg in 1930, and a D. Eng. at the Technische Hochschule, Aachen, in 1934. Before and during his studies he followed the usual miner's career in the coal and hard rock mines of Germany, Austria and Czechoslovakia. He was on such rare assignments as

PROF. RUDOLPH G. WUERKER

shaft sinking by the freezing method, and supplemented his education with geophysical exploration.

As a consulting engineer at the Steelworks Association, Duesseldorf, Germany, he played an important part in the introduction of steel supports in mines. Many of his publications have been printed in the coal mining literature of the world.

In 1935, he went to Korea as a consulting engineer, and transferred two years later to the Philippines. Here he did his first teaching, having been hired by the University of the Philippines to start a program of geophysical surveys. Then Pearl Harbor came along. Dr. Wuerker manufactured dental supplies during the years of Japanese occupation.

After the war Dr. Wuerker was principal engineer in the United States Army Ordnance on captured enemy material and was assigned to a War Department project. On coming to the United States, he was lecturer in the college of engineering at the University of California at Los Angeles.

He is a member of the AIME and a licensed professional engineer, mechanical engineering branch, in California.

In 1951, Prof. Wuerker was presented an award for being the most effective teacher in the mining engineering curriculum in a contest jointly sponsored by the *Illinois Technograph* and the Engineering Council.

PROFESSOR RAY STUERMER

The Navy Pier Architectural Department is extremely fortunate to have on its staff a far-sighted, dynamic, and practical personality in the person of Professor Ray Stuermer.

In the year 1937, Professor Stuermer graduated from the University of Illinois. He served in the Navy during the last war and was released from active duty as Lieutenant (Senior Grade) in 1946. That same year, 1946 Professor Ray Stuermer won two $1,000 awards in the Chicago Tribune Prize Homes Competition. Among the other awards earned by him were: 1937, Second Prize—Ryerson Fellowship; 1937, Finalist and Honorable Mention—American Academy in Rome Competition; 1936, Illuminating Engineering Society Prize and in 1933, First Prize—Architects Club of Chicago Competition. In 1951, Professor Stuermer authored Problem 1 of the Class A Program for the Beaux-Arts Institute of Design—which carries a prize.

Professor Ray Stuermer, a practicing architect in his own right, is consistently propagating the advancement of contemporary architecture. His professional work has covered a wide and varied field of architectural design including housing projects (Ida B. Wells, Chicago Chatham Park, Chicago Altgeld Gardens) industrial plants, an ammunition depot, McAllister, Oklahoma; shell loading buildings, fire stations, bridges, dam, barracks and recreational buildings, power houses (Fisk Street Station, Chicago) as well as many residential and commercial structures. He is at present working toward the development of low cost church buildings using modern methods and materials.

Professor Stuermer encourages his students to look forward and explore the

PROF. RAY STUERMER

new and expanding horizons in the world of architecture, a world richly endowed with many possibilities for the advancement of humanity through design. His activities in practice, as a teacher, and as a Director of the Chicago Chapter of the AIA keep him very busy, but there is always time for a "bull session" with his students to keep them informed of the hazards and joys of the profession.

BOB JOHNSON

Readers of the *Tech* will notice that the Engineering Council seems to have an abundance of presidents, since last month Ed Christianson was named as the holder of this office and this month we introduce Bob Johnson of Chicago as the president of Engineering Council.

The discrepency lies in the fact that, after being named president of Delta Upsilon fraternity, Ed Christianson declined the presidency of the Engineering Council.

(continued on page 30)

production, organization, planning through . . .

industrial engineering

by Pete Cattapan, gen.e. '53

During World War II, production rates were at an unbelievable high. Airplane plants that formerly took five years to build were built in two years. Heavy bombers produced at the rate of one per month, were, within eighteen months, being built at the rate of one a day. These, as well as millions of other production rates, were largely increased by industrial engineers. Production in World War II and during the post-war period definitely established the effectiveness and worthiness of the industrial engineer.

PETE CATTAPAN

Pete hails from Chicago where he graduated from Crane Tech in 1948. After spending two years at Wright Junior College, he transferred to the Navy Pier branch of the University of Illinois where he became associate editor of the Tech.

At present, Pete is a junior in general engineering. After graduation, he plans to enter the field of industrial engineering.

The purpose of this article is twofold: to study industrial engineering curricula in the accredited colleges of the United States, and to survey that occupation.

In order to limit the survey, it is necessary to first define industrial engineering. It is a broad occupational area usually included in the wider field of management engineering. In its restricted usage, it is limited to production organization, planning, and methods. It may include the training and direction of personnel, specifications and purchasing of materials, cost and sales control, health and safety programs, accounting systems, and traffic management. In some instances, this occupation embraces the management of construction of new industrial enterprises and large scale public works. It may also include consultation in the area of finance and economics as these relate to mergers, reorganization, large-scale modernization, and retooling.

In order to understand the development of industrial engineering curricula, it is necessary to know how the field was formed. In 1946, George Filipetti wrote: "The foundation of modern industrial engineering techniques, principles, and attitudes was laid at the close of the nineteenth century by Frederick Taylor." Filipetti's book, "Industrial Management & Transition", shows that Taylor was the first to apply scientific methods to the problems of business management. Early twentieth century writings by such industrial engineers as Ralph Barnes, A. G. Anderson, and G. H. Shepard support Filipetti's statement. These industrial engineers, along with others, developed and spread this scientific management through World War I and its post-war decade.

The first curriculum in this country was initiated at Pennsylvania State College in 1908. In 1910, the new department graduated its first two students. Other colleges followed Penn. State slowly by opening similar departments.

By using the curricula at Penn. State, we can get a general idea as to the nature or scope of industrial engineering. Most courses have been developed by changing and modifying the then existing mechanical engineering classes. The objective of the curriculum has been the same, however, and greater emphasis was placed on subjects in the field of mechanical engineering. Most of the changes have tended to decrease the mechanical engineering content and increase the industrial engineering part of the curriculum. Curriculum changes made in concept with other departments of the school of engineering have strengthened the basic engineering coverage and added courses in the field of humanities.

These courses meet the need of students who enter industrial, commercial

(*continued on page* 18)

Industrial engineers often build complete working models to work from, such as the steel mill shown here.

by Bob Schrader, ch.e. '53

EE Student

Lily Seshu (pronounced say-shoo), from Travencore in South India, has enrolled in the EE grad school this semester. The 25 year old Indian woman already has a bachelor's and master's degree in physics from the University of Travencore. She is especially interested in radio communications and will do her advance work at the University in that subject.

Mrs. Seshu feels right at home at Illinois, since she came from a University of about 10,000 students. Mrs. Seshu decided to enroll at the U. of I. after talking with technical people in India who told her of the engineering and scientific work offered here.

Mrs. Seshu's father was director of public health for Madras. Her husband is also working for the government as an electrical engineer at Allahabad, India. He hopes to join her here in February.

Incidentally, Mrs. Seshu wears her native costume while attending school here.

* * *

The Engineer

He was seated in the parlor—
And he said into the light—
Either you or I old fellow—
Will be turned out tonight.

—Florida Engineer

* * *

Engineering Scholarships

Each year, without undue publicity, over $6,500 worth of scholarships are given to Illini who are engineers or architects. These range from two year tuition-free scholarships for ceramic engineers to a scholarship of $1,000 awarded annually to an outstanding senior in architecture. There are also scholarships in electrical engineering, illuminating engineering and mining engineering.

MRS. LILY SESHU

Scholarships totaling $3,000 are available to any student in the engineering college, with preference going to students in mechanical engineering. These are your scholarships, engineers, so it might pay to do some thinking about them. After all, it could happen to you.

* * *

Heard at the Engineers' Ball, 1929:
"Stop, I'll call the chaperone!"
Heard at the Engineers' Ball, 1951:
"Stop, wait till the chaperone passes by."
Lifted from the *City College Vector*

* * *

Defense Work at the U. of I.

Although it is not readily apparent, the University of Illinois is humming with defense activity. Fifty-four percent of the total engineering research time is devoted to defense work. Departments leading in defense work, with the per cent in time each department devotes are shown below:

Chemical Engineering	60 %
Civil Engineering	21½%
Physics	50 %
Electronics	46½%
Ceramics	28½%

* * *

Oliver Wendell Holmes once mistook an insane asylum for a college. Realizing his mistake, he explained to the gatekeeper and commented humorously:

"I suppose, after all, there is not a great deal of difference."

"Oh, yes, there is," replied the guard. "In this place you must show some improvement before you can get out."

* * *

If all the people who sleep in church were laid out end to end, they would be more comfortable.

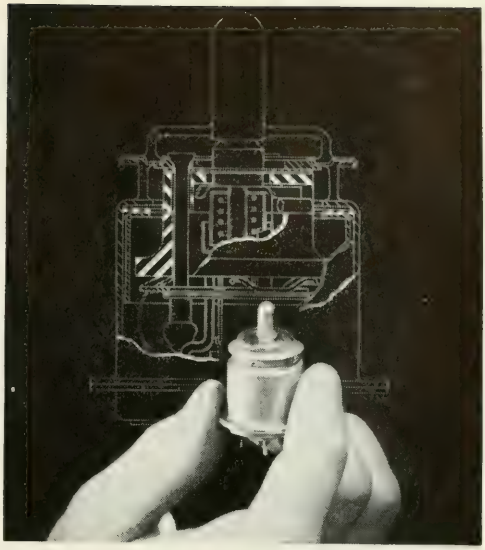
THIS MIDGET TUBE WAS A MIGHTY CHALLENGE

It had Bell Telephone engineers scratching their heads.

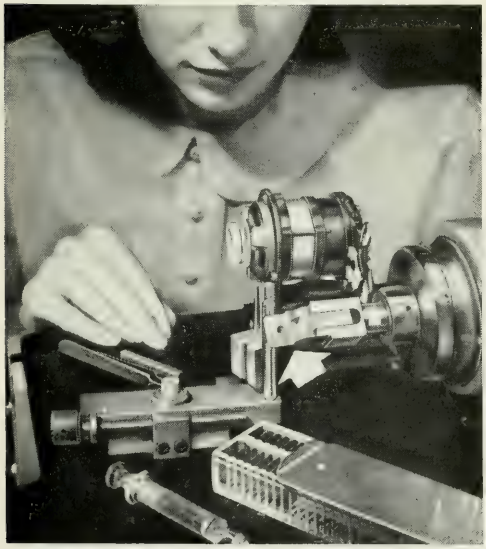
A new kind of electron tube was needed for coast-to-coast *Radio-Relay*. It had to amplify a wide band of super-high-frequency signals. It had to relay them, without distortion, every thirty miles across the country.

That meant splitting hairs. For the working elements of the new tube would have to be five times closer together than in any other tube. And that's mighty close — 6/10 mil between grid and cathode; grid wires 1/3 mil thick, and wound a thousand to an inch.

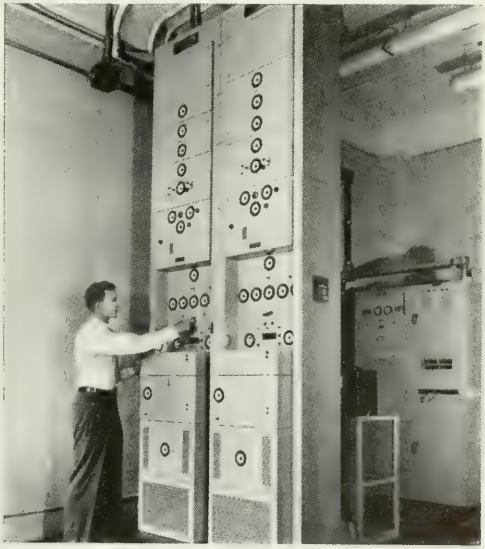
What's more, the tube had to be designed for assembly-line production, then installed and maintained, and its performance on the job analyzed.



The walnut-size midget was developed and the first samples were made by scientists in the Bell Telephone Laboratories. It was a joint project, involving electrical, mechanical and chemical engineers, and skilled ceramic, metallurgical and other technicians.



Quantity production of the (416A) tube was a job for Western Electric, the manufacturing unit of the Bell System. Work had to be done under microscopes. Western's engineers designed new equipment, worked out details of assembly, devised ways to develop skillful workers, simplify operations, keep assembly areas surgically clean.



Engineers in the operating companies and A. T. & T.'s Long Lines Department continually study the performance of the "Mighty Midget" as it plays its part in speeding telephone calls and television programs across the nation. From their studies will come more challenging problems for—and more solutions from—Bell System engineers.

BELL TELEPHONE SYSTEM

skimming industrial headlines

edited by Howie Hadler, ag.e. '54

radioactive glycerine

A discovery of interest to physiologists, pharmacologists, and biochemists familiar with tracer techniques is a recent method for obtaining small quantities of radioactive glycerine. Glycerine, labeled in all positions with C14, is one of the products of photosynthesis by a red marine algae in an atmosphere of radioactive carbon dioxide. Radioactive glycerine will help scientists in their study of the metabolism of fats, the utilization of glycerine by the body, fermentation processes, and various other phenomena. It might also prove a useful tool to engineers studying glycerine manufacturing and refining operations.

sounds you can see but can't hear

High frequency sound waves—sound waves beyond the range of your hearing—are proving to be a useful tool for research and for industry. Scientists find them useful for mixing such naturally insoluble substances as oil and water, or mercury and water. Industrialists find them useful for non-destructive testing of metal castings, and concrete structures; and for mixing paint pigments. Scientists see a future for ultrasonics for improving clothes washers, for agglomerating smoke particles, for pasteurizing milk, for sterilizing containers, and for many other uses.

Scientists at Westinghouse are making a study of the fundamental properties of these waves with the aid of an ultrasonic generator. A jar of oil atop the generator contains the heart of the device; a tiny quartz crystal. The application of electronically generated, high electrical voltage across the crystal causes it to vibrate hundreds of thousands of times a second—about 750 thousand vibrations per second. These vibrations create ultrasonic waves; the pytrasonic waves agitate the molecules in the liquid and, if continued long enough, complete mixing or emulsification takes place.

glycerine softener for nylon

A manufacturer of chemicals for the textile industry recently announced the addition to its line of two glycerine softeners designed for the silk and nylon knitting trade. Both products are combinations of glycerine with cocoanut oil and red oil, and in use are added to water to form emulsions. When applied to yarn, these emulsions impart pliability which insures uniform knitting, yet they do not remove the synthetic resins or sizes which hold the twisted filaments together. In addition, the yarn is lubricated so that it does not cut into or wear out the carrier tubes and needles. One of the glycerine softeners is formulated for general use; the other, for mills which have humidifying systems where lubrication of the yarn is more important than its softness. The manufacturer states that glycerine provides both softness and lubrication, and that it works better with all types of water than other materials.

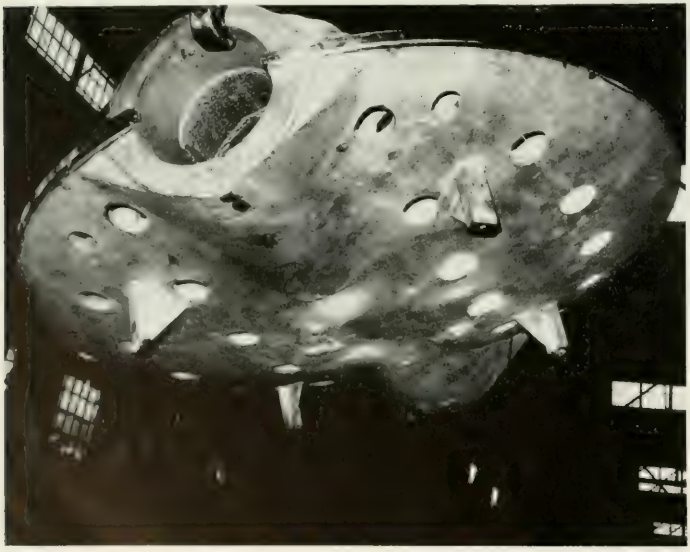
powerful magnet

A cobalt-platinum magnet, which in small sizes, is described as the world's most powerful permanent magnet, has recently been developed.

Present commercial use of the new magnet will be limited, however, not only by the government restrictions on the use of cobalt, but by prohibitive expense of the large amounts of platinum used in the alloy, scientists said.

They do not foresee the new magnet replacing presently used magnetic alloys, such as the Carboloy Alnico magnets, but rather believe that new fields of use

(*continued on page* 22)



flying saucer?

No, it's a 27,000 lb., 120-in. bronze-rimmed, cast-steel leaf for a butterfly valve being manufactured by Westinghouse. The valve will control the flow of water through a penstock leading to a big waterwheel generator in a Southern California hydroelectric power generating station. The holes shown are on the downstream face of the leaf. The upstream face is solid cast steel. The four protruding "legs" are steel supports temporarily welded to the structure to speed machining and other manufacturing operations.

"Put your *X there!*"

"Ever have nightmares?

"I don't, often. But I sure had one last night! Wasn't my usual one, being chased by a lion and falling off a cliff. In *this* dream it was Election Day. I was at the polls, kidding with some of the boys I knew . . . but they weren't kidding back. They looked sort of worried or scared or something.

"Anyway, I got my ballot, stepped into the voting booth and pulled the curtain. I wet the end of the pencil . . . to make my X's big and black. *Then the nightmare part began.*

"A tough-looking soldier stepped into the booth. He put his finger on the ballot and said, *'Put your X THERE! And THERE . . . and THERE . . .'* None of the names I'd picked, either. He had a big black gun pointing right at me.

"That was last night. Today, all day, I've been thinking about it. I'd known that was how some elections got settled in other places. But it never occurred to me before how lucky I was to be a citizen of *this* country. *Here* I vote according to my conscience, not a gun. And I do other things the way I please . . . like going to church, or picking out my own kind of job down at the Republic plant. Try that where there's no freedom!

"That's it . . . *Freedom!* We've got all the Freedom in the world. But, honestly now, do we *really* appreciate it? Do *you?* I admit I've done *my* share of griping . . . probably never will get over that habit.

"But, with Freedom-grabbers at work here as well as abroad, I want to be sure on Election Day that we're *all alone* in that voting booth. With nobody to tell us, *'Put your X THERE!'* No sir!"

REPUBLIC STEEL

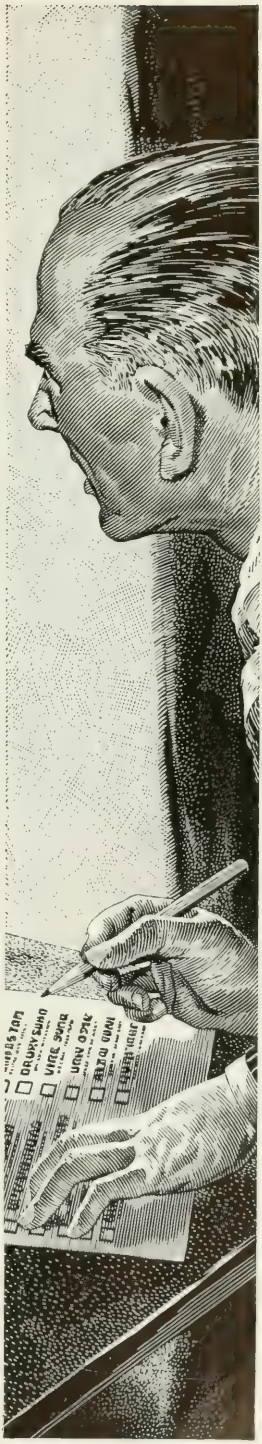
Republic Building, Cleveland 1, Ohio

REPUBLIC STEEL

Republic BECAME strong in a strong and free America. Republic can REMAIN strong only in an America that remains strong and free . . . an America whose many thriving industries have brought the world's highest living standards to her people. *And in serving Industry, Republic also serves America.* Take, for example, the Food Processing Industry. Here untold millions of pounds of food are processed, refrigerated, packed, canned and frozen for the American table. And here Republic's gleaming Enduro Stainless Steel can be found on the job . . . in vats, cookers, sterilizers, mixers, coolers, to name but a very few . . . guarding faithfully the food your family eats.

* * *

For a full color reprint of this advertisement, write Dept. H, Republic Steel, Cleveland 1, Ohio



ENGINEERING . . .

(Continued from page 13)

or financial enterprises; whether public utilities or manufacturing plants. The fundamentals of engineering are supplemented by sequences essential to preparation for industrial engineering such as:

1. Methods: Tool engineering, time and motion study and factory management.

2. Cost Control: Engineering, economy, cost accounting, budgeting control, standard costs.

3. Personnel: Psychology, personnel administration & scientific management.

The primary purpose of industrial engineering is to train students in engineering fundamentals, the second is to train them in engineering management, and the third is to develop a well-rounded graduate.

The curriculum may be divided into four parts: basic engineering (mathematics, chemistry, physics, drafting and mechanics); other engineering courses (thermodynamics, electrical engineering, and fluid mechanics), intended primarily to tie together and round out the basic engineering training; industrial engineering courses (methods, cost control, personnell and coordination) to train students in engineering management fundamentals and acquaint him with the tools and techniques of management, and humanities (English composition, literature, history, and speech) to meet the third objective of developing a well-rounded graduate.

In order to follow the trends in the industrial engineering curriculum, I have abstracted parts from two recent studies made on the subject. Mr. Thuerning at Pennsylvania State College in the fall of 1949 found, in response to questionnaires to former students and their employers, that the following changes were recommended:

Basic engineering—no change

Industrial engineering—expand or no change.

Other engineering—reduce or no change.

Humanities—expand or no change.

In the field of humanities, both the graduates and firms feel that the following subjects should be considered for expansion in the order named: speech, psychology and economic studies. They also favor a course in statistics as well as a course in report and better writing. The present shop training in machine, foundry and welding is adequate.

It seems, from tabulation formulated by Mr. E. Laitala at the University of Illinois that the optional approach to providing industrial engineering instruction seems to have served its purpose and that the degree granting department is taking over. From schools all over the United States, it can be seen that the industrial engineering and management area is no longer considered like frosting on a cake, but rather an integral part of the cake itself. The most common comment, according to Laitala, was that the engineering curriculum in general has undergone study and revision designed toward strengthening the instruction. In a few schools the engineering curriculum now calls for four and a half or five years of study.

A committee at Ohio State University made a study in 1944 of the engineering field. They came up with the following findings:

1. The second World War brought out the importance of preparing for the profession of industrial engineering.

2. The Societies Hammond Committee on "Engineering Education After the War" issued a report emphasizing the need for a careful analysis and revision of the curriculum.

3. The returned vets want the best education obtainable.

4. The trend of education is towards a longer period of schooling.

This study at Ohio State University resulted in a five year engineering curriculum there and at a few other colleges. Most engineering colleges that have the five year curriculum work it on a cooperative basis. An example is Northwestern University where after the first three years, the student alternates a period of schooling with a period of work for two more years.

Some industrial men made a study of the industrial engineering curricula and made these recommendations: industrial engineering education should be aimed at a broad field of specialization. The chief realm of the industrial engineering is in the field of production planning and control, factory layout, cost reduction, manufacturing, expense, budgeting, evaluation, and similar lines. The industrial engineering curriculum should be directed towards an adequate preparation in these fields rather than distributing the students efforts over subjects which have only occasional application. Recommendations were made to broaden the courses in industrial organization, humanities, and industrial relations. The importance of training personal adjustment to business and the cultivation of the spirit of cooperation in all engineering students was emphasized.

The second part of the article shall be devoted to industrial engineering occupation.

One of the first things we want to know is what an industrial engineer does. They make surveys of how industrial plants or businesses are operated, and, on the basis of such studies, prepare recommendations to the executives for changes in the way machinery is made or in the set up of employees. Industrial engineers work principally for industrial enterprises such as manufacturers, electric utilities, firms or management consultants, universities, or are self-employed as consultants.

The greatest demand for industrial engineers appears to be in manufacturing companies where eighteen per cent is needed. Eleven per cent of those employed in steel companies and a very large percentage of engineers employed in miscellaneous business concerns are industrial engineers.

The results of a study made by Mr. R. M. Barnes in regard to the number of industrial engineers employed in relation to the size of a plant are shown below.

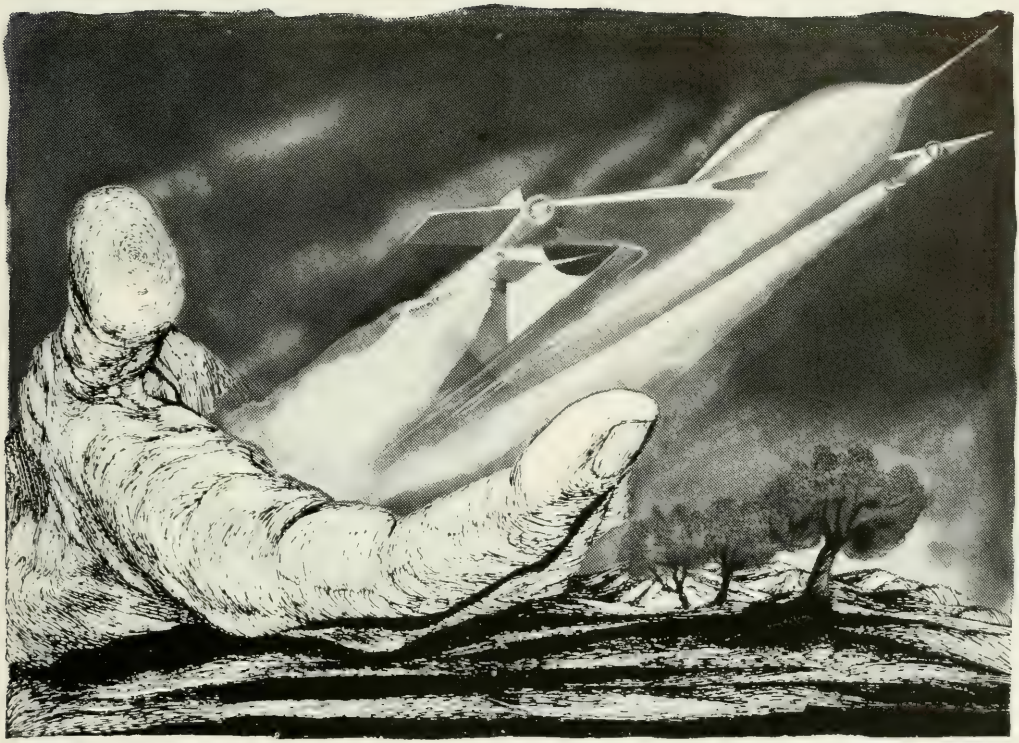
No. of Employees	No. of Ind. Engineers	
0-500	4.5	'46
	3.75	'48
501-2000	11.4	'46
	13.3	'48
2001-15000	34.	'46
	76.7	'48
All Plants	12.4	'46
	25.1	'48

The average size of the eighty plants surveyed in 1946 was 1,800 hourly employees and the "average plant" had 124 people in its industrial engineering department. In 1948, the average size of 89 plants surxeyed was 2,021 and this "average plant" had 251 people in its industrial engineering department, an increase of over 100 per cent. The number of industrial engineers per 1,000 employees has increased from 7 in 1945 to 14 in 1948.

The employment outlook for industrial engineers appears good. Industrial engineering was not an overcrowded field before World War II and was still an open field before the Korean war.

In summarizing, we find that the industrial engineer has come a long way since the days of Frederick Taylor. In the study of the curriculum it is apparent although the basic ideas have not been changed, there have been some changes in industry. There are also indications that the established four year curriculum might be replaced by a five year curriculum or school-work plan. In the brief study of the occupation, we find that industrial engineering covers a large field, but its main purpose is in increasing production most effectively. Engineers work principally for industrial enterprises where management is difficult. The outlook for the industrial engineer is good with salaries limited only by the ingenuity of the individual.

Some men think they have made a success of life, when all they have made is money.



Hottest thing in the skies

JET AND ROCKET SHIPS top them all for high flying speeds —and searing engine temperatures!

Zooming through the air at speeds far faster than sound, their engines generate heat that would soften any ordinary steel.

Special alloy steels to withstand the terrific heat and pressure of the jet powered engines are made by adding such alloying metals as chromium, tungsten and vanadium. Not only in aviation but in almost every field alloy steels are on the job.

Our automobiles and ships are safer and stronger because of the alloy steels used in them. The gleaming, streamlined trains in which we ride get their combination of beauty, strength and lightness from steel made tough and stainless by the addition of chromium.

Furnishing steel makers with alloys essential to the manufacture of special steels is but one of the important jobs of the people of Union Carbide. They also provide the giant carbon and graphite electrodes for the electric arc furnaces which are used to make many of these fine steels.

FREE: *Learn more about the interesting things you use every day. Write for the 1951 edition of the illustrated booklet "Products and Processes" which tells how science and industry use Union Carbide's Alloys, Carbons, Chemicals, Gases, and Plastics in creating things for you. Write for free booklet K.*

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PRESTONE and TREK Anti-Freezes • BAKELITE, KRENE, and VINYLITE Plastics • PYROFAX Gas • SYNTHETIC ORGANIC CHEMICALS

GRILL CLOTH . . .

(continued from page 9)

At high frequencies, eddy currents are induced in the coil former, and the former, with its associated diaphragm, vibrates, emitting desired energy. Since the mass of the voice coil is too great, it is permitted by the elastic coupling to remain at rest, or to respond to any low frequency excitation which may be present. Since very little power is present at high frequencies, there is no danger of the voice coil being required to exceed its dissipation capacity.

The magnetic structure plays an important part in all of this. The flux field it must provide must be uniform and sufficiently wide so that the voice coil is not permitted to leave the region of uniform flux density, else serious distortion, reduced efficiency, and possible speaker damage may ensue. From all the foregoing "yes, but" conditions, it is obvious that designing a single speaker to cover the audible spectrum with minimized distortion is a very arduous, and not always successful task.

Numerous multiple speaker systems have been designed to achieve full, wide range response. They are commonly called "woofer-tweeter" systems, of which the co-axial is the most famous example. In these systems, a crossover network divides the impressed signal; part going to the low frequency reproducer, the "woofer," and part going to the high frequency unit, the "tweeter." In the coaxial speaker the two units are mounted so that their axes are collinear. The tweeter may be a small cone speaker or a small horn.

The woofer is a large cone speaker. Since a small speaker mounted so near a large cone may result in distortion, either due to cancellation or diffraction at or near the crossover frequency, the practice lately has been to make the woofer cone a continuation of the tweeter. This may be done in several ways: the tweeter may be a small cone driven by a small voice coil set inside the center pole of the large voice coil structure of the woofer, with the woofer cone representing an extension of the smaller cone, while another method is to design the center pole of the woofer with a hollowed-out portion corresponding to the flare of a horn, and placing the driving mechanism of the tweeter at the rear. The woofer cone then acts as a continuation of the flared horn. A recent extension of the coaxial system consists of the last described coaxial speaker with a second tweeter mounted at the front of the woofer cone and slightly decentered to minimize diffraction effects. This "tri-axial" speaker extends the high frequency response beyond the limit of average hearing.

(*to be concluded in December issue*)

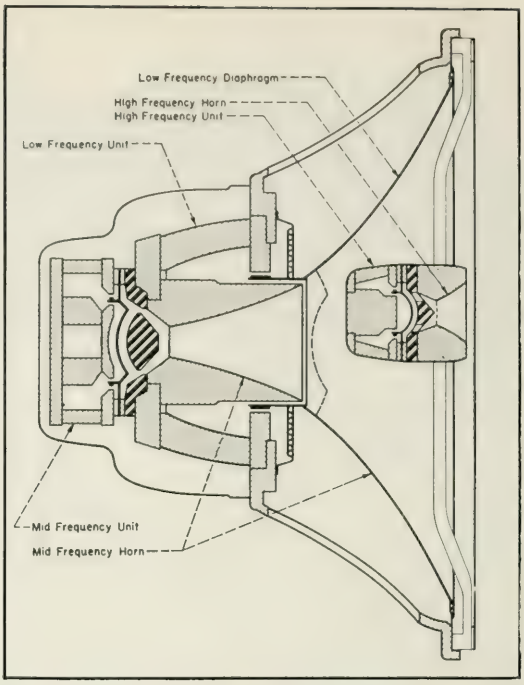

Fig. 2. Cross-sectional view illustrating arrangement of the three channels.

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233)

Of The Illinois Technograph published January, February, March, April, May, October, November, December, at Urbana, Illinois for October 1, 1951.

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Illini Publishing Company, Champaign, Illinois;
Editor, Henry P. Kalapaca, Champaign, Illinois.
Business manager, Richard Kenna, Champaign, Illinois

2. The owner is: the Illini Publishing Company, a non-profit corporation.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: none

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

Richard E. Kenna, Business Manager

Sworn to and subscribed before me this 19th day of October, 1951
(SEAL)
Margaret E. Cain
(My commission expires Jan. 2, 1955.)

New portable radiotelephone, of less weight but longer range, designed and built by RCA engineers.

Longer range, but lighter weight for the "Take-along Radiophone"

You've undoubtedly read how useful our Armed Forces found their portable radiotelephones. Now this indispensable military instrument has become even more efficient.

At the Signal Corps' request, RCA engineers undertook to streamline the older, heavier model—which many a soldier of World War II called "the backie-breakie." Following principles of sub-miniaturization—pioneered at RCA Laboratories—every one of its hundreds of parts was redesigned. Models were built, tested, rebuilt, and finally RCA came up with an instrument weighing only 29 pounds. Its range is double that of the World War II model.

Even more important, under present conditions of pressing need, RCA was able to beat the most optimistic estimate of the time needed to design such an instrument *by nearly three months.* Signal Corps engineers have called this "A major engineering and production achievement."

* * *

See the latest wonders of radio, television, and electronics at RCA Exhibition Hall, 36 West 49th St., New York. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y.

Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
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- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey.
Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RADIO CORPORATION of AMERICA
World Leader in Radio — First in Television

SKIMMING . . .

(continued from page 16)

will be opened, for which existing magnets are not suitable.

Compared with Alnico-5 magnets, generally rated as the most powerful in commercial use, the new magnet is less powerful in large sizes but more powerful in small sizes.

Laboratory experiments with a new magnet about the size of an eraser on a lead pencil, and a similar sized Alnico-5 magnet, show the new magnet to have lifting power 24 times greater than that of Alnico 5, and about eight times more resistance to demagnetization.

"Magnets are limited in size by their tendency to demagnetize themselves if opposite poles, which are at the ends of the magnet, are brought too close together by cutting the magnet shorter and shorter. The new magnet has a strong resistance to this tendency," the scientists explained.

They said that this resistance to demagnetization, called coercive force, enables the cobalt-platinum magnet to be more efficient in smaller sizes than any permanent magnet now in commercial use.

Other advantages of the new magnet are its ductility, or ability to be drawn into wire or thin sheets, and its comparative ease of machining. Alnico magnets

In small sizes, the world's most powerful magnet. (Courtesy of GE).

can be machined only with great difficulty.

Early work on the new magnetic alloy was first done by German scientists in 1935. However, GE research scientists say they have greatly improved the magnetic properties of the alloy over those attained by the Germans.

electric helmsman

Steering a ship by remote control from practically any strategic spot on board has been made possible by a new device called the "electric helmsman" recently developed by GE engineers.

Primary use of this unit would be during combat operations when the normal steering stations had been disabled by enemy fire. In addition, the device can be utilized for effective "close-in" direction of intricate maneuvers such as docking, breeches buoy transfers, and other normal or emergency movements.

The new instrument is controlled by a small knob located on the top of an enclosure which is strapped to the user's chest. The instrument is plugged into the steering control system at special outlets located at widely separated positions throughout the ship. From these points, it is electrically coupled with a special steering power unit in the steering engine room where the rudder mechanism is located.

The unit is now being fitted on a destroyer for Navy use. An earlier model has been successfully tested on a similar Naval vessel during the past two years.

A Utah woman kept coming back to the mobile unit for additional chest X-rays. Finally the nurse on duty asked the woman, "Isn't this the fifth or sixth time you've been in for an X-ray?"

"Oh, yes—and it's wonderful!" the woman exclaimed. "I feel better after every treatment."

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for every engineering need

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great future

YOUR FUTURE

There's a better future—a better job—waiting for engineers at Lockheed Aircraft Corporation, in beautiful San Fernando Valley. At Lockheed you are well-paid from the start; work in modern, air-conditioned offices; receive training that prepares you for promotion—you are part of a team known for **leadership in aviation.***

These Lockheed planes show why Lockheed—
and Lockheed engineers—earned that reputation for leadership:

THE VEGA—
flown to fame by Charles Lindbergh, Amelia Earhart, Wiley Post.

THE HUDSON BOMBER—
first American plane to fight in World War II.

THE P-38 LIGHTNING—
first 400 mile-per-hour fighter-interceptor.

THE F-94—
first all-weather jet interceptor assigned to duty with America's aerial defense forces.

THE SUPER CONSTELLATION—
larger, faster, more powerful, the plane that bridges the gap between modern air transport and commercial jet transport.

The jet of the future—the plane you will help create—belongs in this frame. There will always be empty frames like this, waiting to be filled by Lockheed engineers. That's why Lockheed will always need forward-looking engineers. So why not make Lockheed's great future **your** future. See your placement officer for illustrated brochures explaining work—and life—at Lockheed.

If your placement officer is out of brochures, write:

M. V. Mattson
Employment Manager

LOCKHEED
AIRCRAFT CORPORATION
Burbank, California

*Aeronautical training is not necessary; Lockheed will train you.

NAVY PIER . . .

(continued from page 10)

presented the bell to the Chicago Undergraduate Division.

This bell which was on locomotive no. 1150 rang while pulling such famous trains as the crack Panama Limited. It rang again on the morning of February 10, 1951 when a distinguished group of the State and railroad officials used it to signal the commencement of the second century of the transportation organization.

Dean Trezise in accepting this memento remarked, "President Johnston: On behalf of the college of engineering of the Chicago Undergraduate Division of the University of Illinois, I accept this bell from the Illinois Central Railroad. It has served you well. We recognize its symbolic value in that it was chosen to herald in the second century of high achievement. We are not only honored to accept it on this occasion as an honor bell, but we are deeply sensitive to the sentiment which it carries. It has achieved its place of honor after years of service. We pledge you that it will be so held in high respect by the college of engineering.

The names of the students hereon will be etched in honor. May its gleaming surface never tarnish, but shine in the reflected honor of credit to the University with gratitude to the state and in devoted service to humanity.

WAYNE E. JOHNSTON

Each privilege brings its obligation. May the students whose names will be engraved on the bell and those who will be subsequently so honored never cast a stain on its surface or the name of Alma Mater."

The function of this bell at the Chicago Undergraduate Division will be to honor those students recognized for superior scholarship in the college of engineering. The names of these students will be inscribed on the bell:

January, 1948
William Keith Miller
Frederick Le Roy Voelz
June, 1948
William H. Eisznes, Jr.
Robert B. Laube
January, 1949
Gordon W. Breuker
Bruce W. Capek
June, 1949
James D. Cleary
Harry F. Hillman
January, 1950
Thomas F. Leahey
Robert Uyetani
June, 1950
Desmond Francis Colford
John Paul Tisevich
January, 1951
John Itsuo Kaya
Henry Michael Musal
Harry D. Newman

The CONGRESSIONAL RECORD of 19 September carried the following speech by Representative Crum-

(continued on page 28)

Big Tannery Cools Remarkable Storage with Frick Refrigeration

Refrigerating Machine Room, Cooling Tower and Condensers at the Byron Tannery

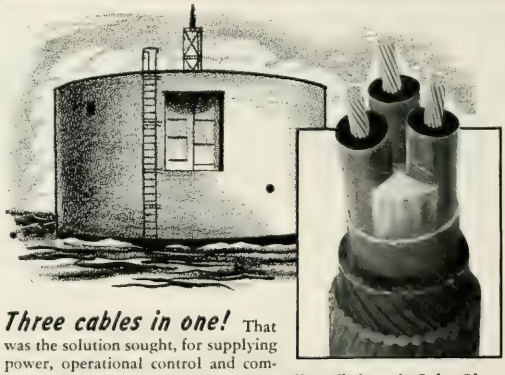
Two Frick Ammonia Compressors at the Byron Tannery, Williamsport, Md.

W. D. Byron & Sons of Maryland have operated a well known tannery at Williamsport since 1897.

The hide storage room, measuring 96 by 46 ft., is now air conditioned by a special Frick system of the central-station type. Temperatures between 31 and 33 degrees F., and relative humidities of 85 to 90 per cent, are constantly maintained. (In a room that cold, such a high moisture content is most unusual.) Shrinkage losses are thus prevented, and the 600 tons of hides are kept in first-class condition. H. G. Burrill & Associates, Baltimore, consulting engineers.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

DEPENDABLE REFRIGERATION SINCE 1853
FRICK CO.
WAYNESBORO, PENNA., U.S.A.
Also Builders of Power Farming and Sawmill Machinery



Three cables in one! That was the solution sought, for supplying power, operational control and communication to a pumping house 4½ miles off shore in Lake Okeechobee, Florida.

As usual, Okonite engineers were consulted on the problem. Their studies showed that it was possible to combine a three-fold function in one cable. This was accomplished by the use of Okolite high-voltage insulation whose electrical characteristics permitted carrier current to be superimposed on the power conductors.

The result was a single Okonite-insulated cable—steel-armored for the 4½ underwater miles, with a non-metallic sheath for an additional 2½ miles underground—which supplies not only power and operation control, but a communication circuit as well.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE insulated wires and cables

8787

AL ENDRES IS ONE of a team of Standard research men engaged in testing the effectiveness of a new powder against plant fungi in the greenhouses at Whiting. Men at Standard Oil's Whiting laboratories often work in close conjunction with research projects at university centers.

AL CHECKS EFFECTS of a spray on an apple tree with Lloyd Boyd. This is part of another project being carried on in our Whiting greenhouses. Al also worked on control, and corroborative tests that led to development of petroleum fractions to kill weeds.

How chemistry is winning the War on Weeds

AGRICULTURAL weed control has for a long time presented chemistry with one of its most interesting problems. Recent successes in this field by petroleum scientists demonstrate the broad scope of activity to which research men in Standard Oil's Whiting laboratories are daily exposed.

The story of weed control begins with wartime manpower shortages on truck farms. Vegetable crop failures increased because weeding could not be done by hand. Scientists discovered that certain petroleum cuts would rid carrot crops of weeds without harm to flavor.

This led to further experiments on the weed-killing possibilities of petroleum fractions by Dr. B. H. Grigsby and his assistants at Michigan State College—cooperating with groups of scientists at other agricultural colleges. Great progress was made on weed-control in the cultivation of celery, asparagus, caraway, dill, parsnips, and cranberries.

Another tough weed-elimination problem was crab grass. To do the job, it was necessary to find a killing agent which would knock out the crab grass, yet leave other grasses unharmed. Recently, Standard Oil has been able to announce successful test results on the petroleum fraction which is today's miracle crab grass killer.

These are just a few of the many problems that give young Standard Oil research men the satisfaction of knowing they have contributed to an advance in our way of living through new uses for petroleum and petroleum products.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

WATER . . .

Continued from page 7

cooperation with the fewest possible federal agencies involved. Referring to the Missouri Valley Authority, Chinn said, "The Missouri Basin Comprehensive Plan has so many agencies involved and such a multitude of generalities, plans, and details covering everything from major stream improvements to gopher eradication, and teaching people how to use electricity, that it appears it may never produce any action of benefit to speak of, and may eventually collapse of its own weight."

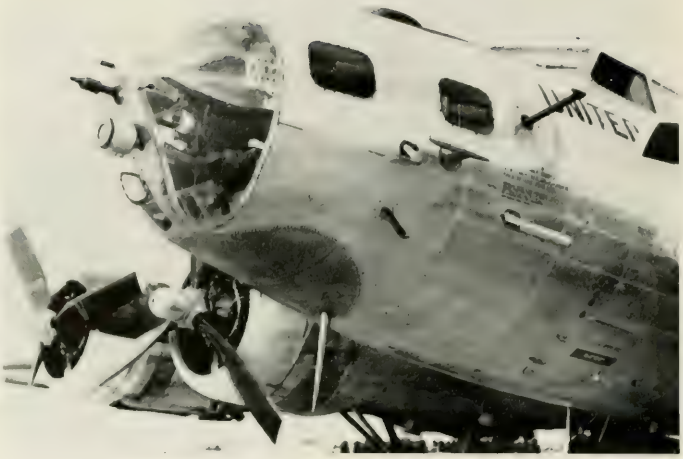
At the same session, William F. Guyton, a consulting engineer from Austin, Texas, spoke on "Analysis and Use of Groundwater Data." There is no national water shortage," said Guyton. Guyton showed that intelligent use of our water resources would prevent serious shortages which, he pointed out, are definitely local in character in Illinois.

Two other papers by Richard Hazen, New York Consulting Engineer and Stifel W. Jens, St. Louis Consulting Engineer, rounded out the basic data use part of the program.

The final hydrology session had to do with "Water Use." Louis R. Howson, Chicago Consulting Engineer, told the Conference that "America's fresh water supplies are not vanishing and shortages are neither universal nor increasing."

Howard E. Degler, Kansas City Private Water Conservation Engineer predicted widespread use of chemical seawater freshening, particularly for coastal cities within 25 years. Along the same

(*continued on page 28*)



Weather men of MIT flew to the conference in their "Weather Plane," a B-17 equipped with many special devices for measuring weather.

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To help solve this critical problem, Honeywell's Aeronautical Division engineered a special adaptation of the Honeywell Electronic Autopilot. Coupled with the bombsight, the Autopilot flies the plane truer than any human pilot. No wonder it's said the B-36 can "thread a needle" 45,000 feet below!

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MINNEAPOLIS **Honeywell**

First in Controls

WATER . . .

(*continued from page 26*)

line Paul W. Reed of the U. S. Water Pollution Control Division in Chicago told the Conference that fresh water supplies are the backbone of our national existence and must not be wasted. He said, "Water destruction by pollution deprives us of its use as surely as if it weren't there." Walter Picton, of the National Security Resources Board, spoke of a tremendous increase in water consumption in the last fifty years for such uses as irrigation, farms, municipalities, private industries, and steam power generating plants. "Responsibility for intelligent planning of water supply and use should be local, with the full benefit of federal advice and coordination," Picton said.

The Chemistry sessions were held on only one day, Tuesday, October 2, and were devoted to four addresses. In the first one, H. H. Uhlig, Director, Corrosion Laboratory, M.I.T., Cambridge, Massachusetts spoke on "Corrosion Fundamentals." He told the conferees that more basic research is needed from universities and industries to discover new techniques and improve existing ones for control of waterway corrosion which causes billions of dollars damage annually and wastes precious manpower and metals.

Professor W. H. Rodebush of the physical chemistry department, University of Illinois, reported that his department and the State Water Survey have learned some more things about water and ice behavior during the last 15 years of cooperative research. He spoke of finding that free water in some plants crystallizes in temperatures above the freezing point, which is why some varities of corn are killed by temperatures around 40° F. In winter wheat, he said, this crystallization of free water occurs slowly and so does not damage the cells. Also at the chemistry session papers by A. S. Behrman, Chicago consultant and F. G. Straub, research professor of chemical engineering at the University of Illinois were heard.

The Weather-Radar Conference at the Allerton Park was attended by 133 scientists from all over the United States and three foreign countries.

This was the first conference meeting of this group since 1947 when a few weather-radar scientists met informally at the Massachusetts Institute of Technology. Radar weather men of the Massachusetts Institute of Technology flew to the conference in their "Weather Plane" a B-17 equipped with many special devices for measuring weather. The purpose of this plane is to take observations in weather that is being observed by ground radar. It contains equipment for measuring temperatures, pressure, dew point, turbulence, size of drops, and for capturing and preserving individual drops and snow flakes while flying through the disturbance zone.

While most of the papers presented at the Weather-Radar conference were of a highly technical nature, they all aimed at the use of radar in solving the more perplexing weather problems. At M.I.T. for instance, the Weather-Radar group is interested in why it rains. The Illinois State Water Survey Weather-Radar scientists are interested in how much rain falls when it is raining, in addition to the areal distribution of rain.

The Survey maintains two weather-radar stations in Illinois in a cooperative research program with Illinois farmers and others interested in improving weather data collection.

Highlight of the conference was the dedication banquet on Tuesday evening in the Illini Union at which Director C. Hobard Engle of the Department of Registration and Education delivered the key of the new Water Resources Building to a representative of the University of Illinois. Over 500 of the nation's top scientists attended the conference during the three-day session.

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NAVY PIER . . .

(*continued from page 24*)

packer (R, 3rd Dist. Indiana; B. S. eng. N. U. '38) which will be of interest to engineers:

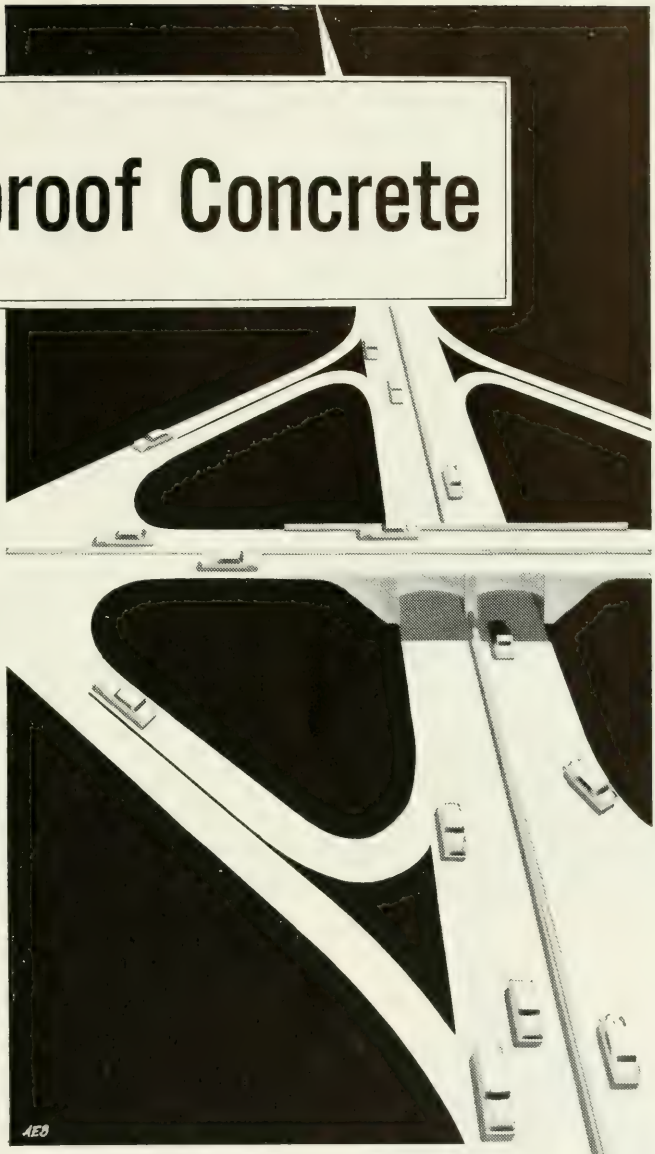
"Mr. Speaker, I have today introduced a bill authorizing the Postmaster General to issue a special postage stamp during 1952 commemorating the centennial of the American Society of Civil Engineers.

One hundred years ago, engineering in America was divided into only two branches—military and civil. Although we now have many specialized branches of engineering and many national societies of engineers, all are a part of the one-time civilian or civil engineering profession. As such, all have a real interest in celebrating the centennial ofengineering in 1952.

During the past century, our country has developed to a position of world leadership very largely through the contributions of engineering and technology. The centennial celebration is viewed as an opportunity to commemorate the services of the engineering profession and to bring to the people of this country and of the world a more complete understanding of the reasons why the United States has become great, and of the contributions of engineering to its development.

(*continued on page 30*)

Climate-proof Concrete



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. . . concrete for highways that will withstand the destructive effects of freezing weather.

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. . . cement made with Vinsol® Resin . . . a low-cost Hercules rosin derivative. When added to Portland cement in minute quantities, it makes concrete that's filled with tiny bubbles of air. This entrained air serves as an internal "cushion" against alternate freezing and thawing . . . prevents damage to the pavement. Today, Portland cement manufacturers use more Vinsol for highways and structural jobs than all other air-entraining agents combined.

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18 superlative degrees that match every mood of genius. Ask for CASTELL 9000 at your college supply store.

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NAVY PIER . . .

(*continued on page 28*)

All of us have enjoyed the benefits of the engineering and technological progress than has placed us in the forefront of the nations of the world. While the United States occupies only six percent of the land area of the world, and although we have less than seven percent of the world's population, we possess 58 percent of the world's telephones, 76 percent of the world's automobiles, 31 percent of the world's radio and TV sets, 40 percent of the world's electrical production, and 27 percent of the world's newspapers.

Mr. Speaker, in fairness to the engineering profession and ourselves, I think we should take this opportunity of recognizing the tremendous service to our national progress which it has helped to make possible. In our present critical times it is important for us to take this opportunity of reviewing our history so that everybody will understand and appreciate why our American system has made us the world's leading nation."

A S C E

At their final meeting in the Spring, 1951 semester, the Society elected the following engineers to serve as officers for the forthcoming semester: Benjamin Svoboda, President; Robert Crescio, Treasurer; and James H. Trail, Secretary. The Society has planned several interesting meetings and will present prominent engineers from the various fields of the profession. Meetings are held the first Tuesday of each month and all interested engineers are welcome. Professor J. C. Chaderton is the sponsor.

A S M E

The student branch of the American Society of Mechanical Engineers held its first meeting on Tuesday, September 25th. Associate Dean of Engineering Trezise addressed the students encouraging them to take part in student activities. Mr. Norman R. Sherman, Personnel manager - Link - Belt Company spoke on "What Industry Expects of Young Engineers."

Officers elected at this meeting are Milton Diller, Chairman; Harry Rogers, Vice Chairman; Oliver Smith, Secretary and Gerhard Gauger, Treasurer.

Professor J. S. Kozacka is honorary Chairman and sponsor.

A I E E

The following students were elected to offices of the student chapter of the American Institute of Electrical Engineers at their meeting held September 25th: Charles Kersch, President; Melvin Mendralski, Vice President; Felix Prosia, Treasurer, and Vito Minerva, Secretary.

Featured at this meeting was a showing of an Illinois Bell Telephone Company movie illustrating electronic devices in telephony.

A I A

The student chapter of the American Institute of Architects at their initial meeting elected the following officers to serve for the 1951-52 season: Louis Moro, President; Robert Brittain and Warren Anderson, Vice Presidents; Paul Ehrlich, Secretary; Dan Grimsich, Treasurer; and Don Pyskacek, Historian.

Professor H. B. McEldowney is the sponsor.

INTRODUCING . . .

(*continued from page 12*)

Bob Johnson, present holder of the office, is a June, 1952 graduate in aeronautical engineering. He came here from Hirsch high school in Chicago. Active in many endeavors here on campus, Bob is an active member of the Institute of Aeronautical Sciences as well as being a member of Gamma Alpha Rho and Sigma Phi Delta, engineering social fraternity.

This is Bob's fourth semester as a

BOB JOHNSON

member of the Engineering Council. Last year he was chairman of the St. Pat's ball committee. Also, he is a former *Tech* staff member.

Bob has no immediate plans for after graduation. Since he is in the advanced Air Force ROTC, he says that he will receive his reserve commission and be placed on active duty. His past military experience consists of membership in the International Guard.

Bob calls himself a "frustrated industrial designer." His hobby is art, and once loose of Uncle Sam's fetters, he believes he would like to do industrial design work.

Do you want a career with a future ?

More and more of America's outstanding engineers are carving fine careers for themselves at Boeing. They've found a future here in an Engineering Division that's been growing steadily for over 35 years.

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More housing is available in Seattle than in most other major industrial centers. Or, if you prefer the Midwest, similar openings are available at the Boeing Wichita, Kansas, Plant. Inquiries indicating such a preference will be referred to the Wichita Division.

Decide *now* to build your career at Boeing after graduation. Boeing has continuing needs for experienced and junior aeronautical, mechanical, electrical, electronics, civil, acoustical and weights engineers for design and research; for servo-mechanism designers and analysts; and for physicists and mathematicians with advanced degrees.

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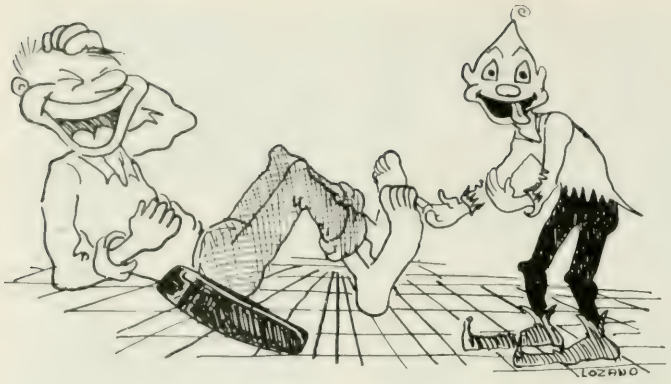


TECHNOCRACKS

edited by Tom Tucker, ch.e. '53

As a service to our readers who are "slightly" hazy on their rhetoric, we print the following:

PARTS of SPEECH

NOUN: What you call your girl. There are proper nouns and common nouns. A proper noun is what you introduce her to other people by. A common noun is "darling."

VERB: What freshmentry to write sentences without.

ADJECTIVE: A word of richness and vigor which must not be used in polite society.

ADVERB: What you use to really split an infinitive with.

CONJUNCTION: What you stall around with when you don't know what to say.

ARTICLE: A word of indefinite value, depending on whether you are writing a telegram or a thousand word theme.

PREPOSITION: The favorite word for ending a sentence with.—Very poor grammar. Use a period.

* * *

IN MEMORY OF
MRS. ALPHA WHITE
WEIGHT 300 LBS

Open wide ye heavenly gates
That lead to heavenly shore.
Our father suffered in passing through,
And Mother weighs much more.

* * *

Would you like to be buried alive?
No, I'd rather die first.

* * *

Teacher: What does s-t-o-i-c spell?

Boy from you-know-where: A stoic? That's the boid what brings babies.

The Iowa Engineer has reported on research done on the dynamics of lipstick distribution. This research is based on two fundamental laws of engineering.

1. When two surfaces meet, one of which is coated with a layer of lipstick, a certain distribution of the lipstick takes place.

2. The second surface, which was originally clean, retains part of the material.

Using these laws, an important equation is derived.

$$D = \frac{(P)(N)+(t)/(I)}{-(A_1)(A_2)-T+(P)(Q)}$$

D is the lipstick distribution, P is the pressure in *psi*, N is the number of applications/minute, t is the time in seconds, and I is the intensity of the light. It is to be noted that the density of lipstick varies inversely as the intensity of light. Thus, as the light goes to 0, the amount of lipstick will approach infinity.

Continuing with the formula, A1 and A2 are the area of transmitter and receiver respectively, T is the temperature (centigrade temperature of the mouth), and Q is the surface condition (determined by coefficient of friction). Experimental verification of this equation will require a great deal of research. Any volunteers?

* * *

'Tis the night before payday, and all through my jeans I've hunted in vain for the ways and means. Not a quarter is stirring, not even a bit; the greenbacks have left me, the pennies have quit.

"Forward, turn forward, O time in thy flight, and make it tomorrow just for tonight!

An Indian struck oil so he went into town to spend his money. Among other things, he bought the most expensive car available. With the driving lessons the salesman gave him, came this advice: "When you see something coming toward you, pull off the road and let it pass."

The next day the Indian was back. He wanted a new car. The other one was no good. When asked why, he explained, "Me see dog coming down road. Me pull off. Let go by. Me see car coming down road. Me pull off. Let go by. Me see bridge coming down road. Me pull off to let go by. BOOM! Car no good."

* * *

"Is that you, Charles?" It was the voice of an angry woman.

A jolly voice, "Zash me, dear."

"Here I have been standing at the head of these stairs for two hours. Oh, Charles! How can you?

The man straightened up somehow. "Shtanin' on yore head on the stairs! Jenny, I'm sh'rized! How can I? I can't! Two hours, too! 'Shtror'inary woman!"

* * *

His father had taken Sandy to the theater. In his eagerness to get a front seat in the upper balcony, Sandy fell into the pit.

His father leaned anxiously over the rail and called:

"Come back here, Sandy, fer goodness sake; it's haulf a croon extra doon there."

* * *

Some of the first American jokes were those inscribed on New England tombstones. The following are some of the better ones.

Beneath these stones do lie,
Back to back, my wife and I.
When the last trumpet the air shall fill,
If she gets up, I'll just lay still.

* * *

This stone was raised by Sarah's lord
Not Sarah's virtues to record—
For they're well known to all the town—
But it was raised to keep her down.

* * *

"Was his bankruptcy due to a lack of brains?"

"Yes, a lack and a lass."

* * *

"I want to see a doctor. Be this the place?"

"This is where I practice."

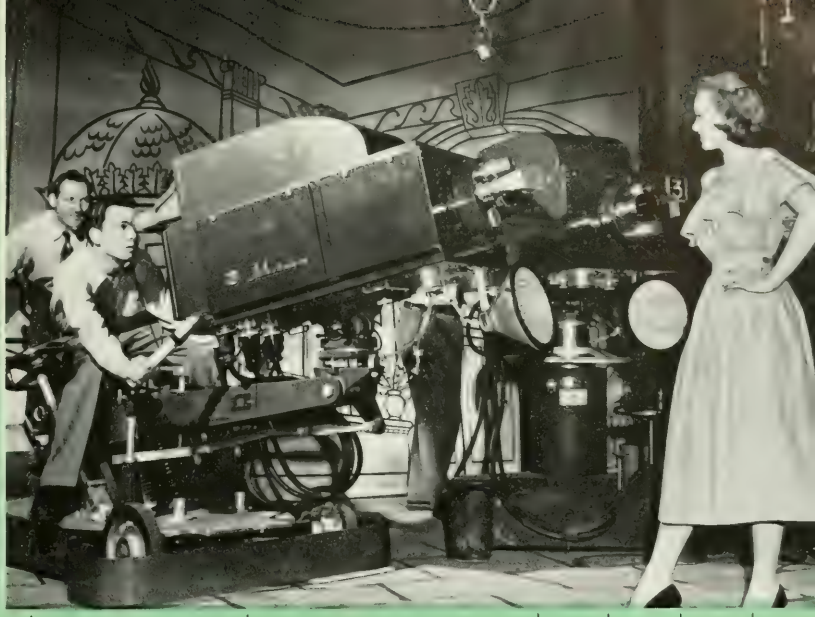
"Don't want no person to practice on me; I want a doctor to cure me."

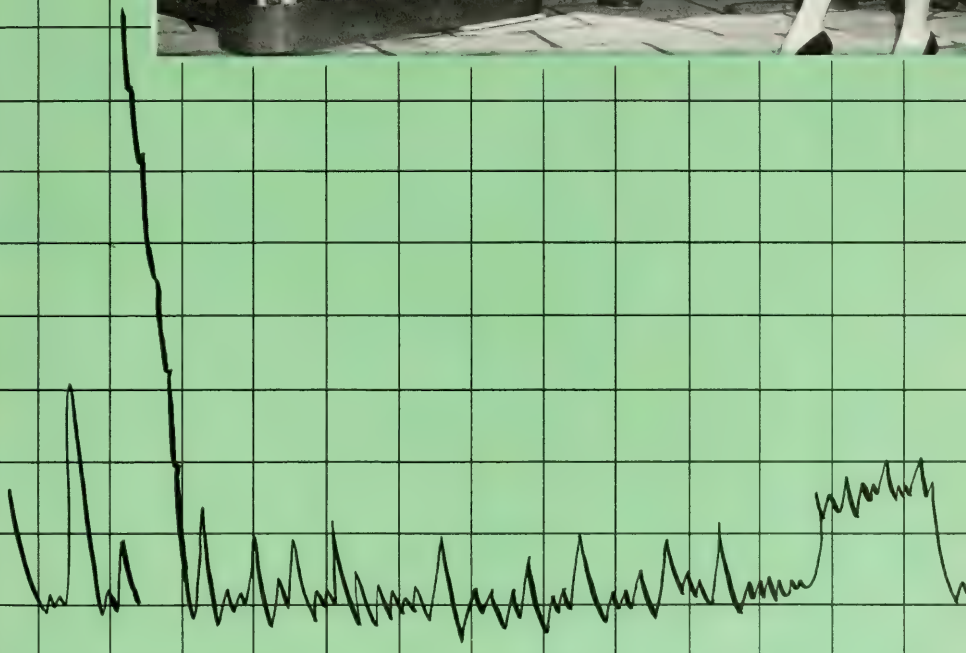
* * *

"But you should love your enemies," the preacher told the Indian.

"I do," answered the Red-man. "I love rum, whisky, tobacco, and women."

25¢





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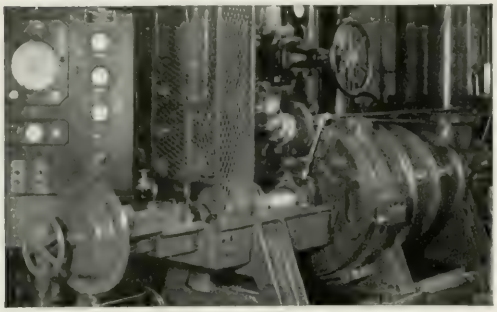
Another page for **YOUR BEARING NOTEBOOK**



How to help a plug keep plugging

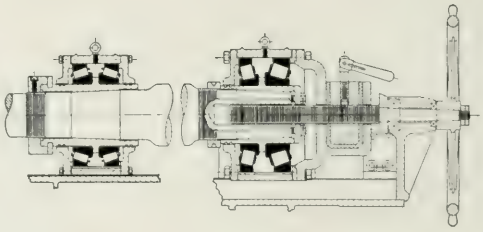
Pulp for paper making is chewed up inside this Jordan engine by a cone-shaped plug that forces the pulp against knife edges in the shell. Clearance between plug and shell must be held extremely close, so the designers mounted the plug shaft on Timken® bearings. Timken bearings take radial and thrust loads in any combination, keep shafts in positive alignment. Deflection and end movement are eliminated.

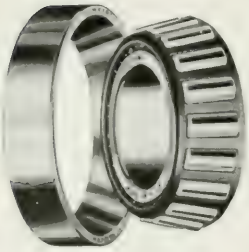
Mounting plug shaft bearings

The application shown here uses four single-row Timken tapered roller bearings mounted in pairs for the thrust and floating ends of the plug shaft. They are mounted directly on tapered sleeves and adjusted by means of shims between the cup follower and bearing housing.

The right hand or thrust end bearing assembly carries the thrust load and is clamped on the shaft by means of an end cap and cap screws. A nut next to the tapered sleeve facilitates removal of the bearing assembly.

Both thrust and floating ends are free to move laterally as the plug and shell are adjusted for clearance. Closures are of the piston-ring type.





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BEARING TAKES RADIAL ⓪ AND THRUST —⓪— LOADS OR ANY COMBINATION ✳

Faith of an Engineer . . .

I AM AN ENGINEER. In my profession I take deep pride, but without vainglory; to it I owe solemn obligations that I am eager to fulfill.

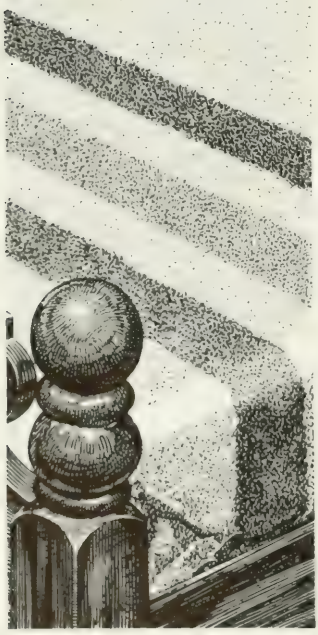
As an Engineer, I will participate in none but honest enterprises. To him that has engaged my services, as employer or client, I will give the utmost of performance and fidelity.

When needed, my skill and knowledge shall be given without reservation for the public good. From special capacity springs the obligation to use it well in the service of humanity; and I accept the challenge that this implies.

Jealous of the high repute of my calling, I will strive to protect the interests and the good name of any engineer that I may know to be deserving; but I will not shrink, should duty dictate, from disclosing the truth regarding anyone that, by unscrupulous act, has shown himself unworthy of the profession.

Since the Age of Stone, human progress has been conditioned by the genius of my professional forbears. By them have been rendered usable to mankind Nature's vast resources of material and energy. By them have been vitalized and turned to practical account the principles of science and the revelations of technology. Except for this heritage of accumulated experience, my efforts would be feeble. I dedicate myself to the dissemination of engineering knowledge, and, especially to the instruction of younger members of my profession in all its arts and traditions.

To my fellows I pledge, in the same full measure I ask of them, integrity and fair dealing, tolerance and respect, and devotion to the standards and dignity of our profession; with the consciousness, always, that our special expertness carries with it the obligation to serve humanity with complete sincerity.



Jimmy said *two billion prayers*

"'God bless everybody!' he said . . . short and sweet.

"Then I kissed him goodnight, tucked him in, put out the light and went downstairs.

"That was a *big* order! Two billion people on this earth . . . and Jimmy was praying for them *all!*

"Now . . . if *you* were going to have that many people blessed, what *one* big blessing would you wish for them all?

"Freedom! What finer thing than Freedom for all the peoples of the world? Why, anybody who knows what our Freedom really means would give his eyeteeth to be an American citizen. Let's see why:

"Here we have freedom of religion. Our newspapers can say anything they want and so can we, short of libel, slander or sedition. Our kids are taught Freedom from kindergarten up. Here we have a free choice of places to live in, businesses to go into or jobs to work at, like mine at Republic (you ought to see the steel we're producing down at the plant!)

"Come voting time, nobody sees us mark our ballots . . . nor can he know *whom* we vote for. And we can squawk our heads off in town meetings or write what we think to our Congressmen . . . and nobody puts us in jail for it.

"As long as we don't step on the other fellow's Freedom, we Americans are the freest people in the world. But there are plenty of people trying to rob us of those Freedoms and run things *their* way. *Outside* enemies . . . but we have plenty *inside*, too. They sneak into our schools, businesses, unions, social clubs . . . *everywhere!*

"Let's keep an eye on those who attack our Freedoms . . . while Jimmy prays for the other two billion whose greatest blessing would be the Freedoms we already *have!*"

REPUBLIC STEEL

Republic Building, Cleveland 1, Ohio

REPUBLIC STEEL

LIKE GOLD, SCRAP IS WHERE YOU FIND IT! And there's scarcely an industry, business or storage yard that cannot yield a rich load of Scrap Iron. *Do you know that* it takes 100 tons of Scrap Iron to produce 200 tons of *new* steel? Of course, you know how badly America needs that new steel today. For Defense. For Construction. For Production. And for Civilian needs. Prospect around your place for all the discarded, broken, worn or obsolete equipment, tools and machines *today*. And sell it to your local "junk" dealer for Scrap *tomorrow!*

* * *

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the illinois technograph

volume 67 **number 3**

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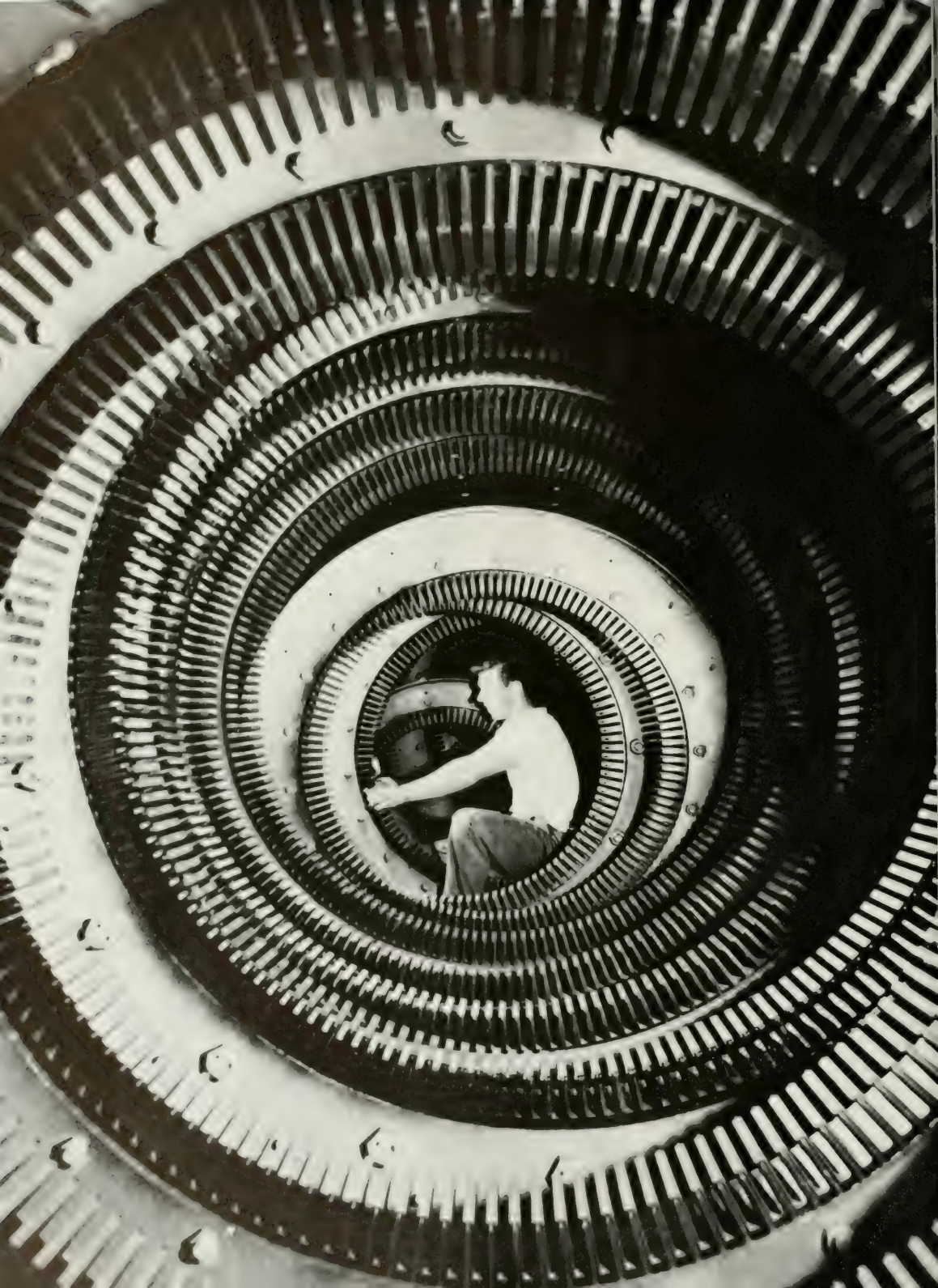
our cover

Color television cameras get a close-up of one of the entertainers who appeared on the field tests of the RCA all-electronic compatible system of color television. (Courtesy of RCA).

our frontispiece

Round and round he goes, and when he stops, this workman will have finished inspecting a series of large stator frames for electric motors. These stator frames constitute the stationary portion of electric motors, inside which rotors spin to produce mechanical power. (Courtesy of General Electric).



cleaner air through . . .

aerosol research

by Tom Tucker, ch.e. '53

Air is generally assumed to consist of 79 per cent nitrogen, 20 per cent oxygen, 0.2 per cent argon, a varying amount of water and traces of other substances. Everyone knows how important the oxygen and nitrogen are to the plant and animal life on earth, but very few know the effect those "other substances" have. Some of them are chemically inert, others are not, but practically all are enough of a nuisance to be considered an air contaminant.

Air contaminants are of two general classes, gases and aerosols. The contaminants are formed in part by nature, but man must shoulder the blame for most of them. Combustion products of gas, oil, and coal and discharges from chemical and metallurgical processes, refineries, incinerators, disposal plants, and stockyards furnish most of the fumes and dust in the air. Some discharges, however, are not obectionable until nature oxidizes them or otherwise changes them by a photochemical process. Nature also disperses and dilutes these by the action of winds. At other times she turns about and holds the annoying particles near the ground, often with disastrous results.

The most important of the gases that pollute the air are the sulfur compounds. Sulfur dioxide in concentrations of 0.5 *ppm* parts per million by volume) is injurious to vegetation. The average person tastes and smells SO_2 at 3 *ppm*. At 10 *ppm* severe throat irritation occurs. At 15 *ppm* a human can endure only one hour. Sulfur dioxide is also responsible for a great part of the corrosion of metal articles. It is slowly oxidized by action of the sunlight to sulfur trioxide, the anhydride of sulfuric acid. In the presence of the water vapor in the atmosphere, the latter forms sulfuric acid mist. Hydrogen sulfide is not often found in appreciable quantities in the air, because it is easily oxidized to sulfur dioxide, the lesser of the evils.

It is easy to eliminate the hydrogen sulfide problem by oxidation. It does not, however, do anything to improve the sulfur dioxide problem. A good laboratory method for removing the gas is absorbtion in water or a water solution. Since it requires about 25 tons of water to absorb the SO_2 formed by the combustion of one ton of coal, the treatment plant must be quite large. Hence,

TOM TUCKER

Tom is a junior in chemical engineering. In the past two years at Illinois, he has worked his way to an assistant editor's job on the TECH. He has also worked on committees for the engineering open house in 1950 and St. Pat's Ball in 1951.

In addition to these engineering activities, Tom is a member of the University concert and marching bands. He is also on the board of directors of the Cosmopolitan.

In spite of his extracurricular work, his class work has been good enough to gain him entrance into Phi Eta Sigma and Sigma Tau.

the method is not widely used in industry. Other disadvantages to this method are the high costs and the lack of places where the sulfurous acid formed can be dumped. The Engineering Experiment Station has studied means of oxidizing the SO_2 to SO_3 over a catalyst and absorbing in water at the same time. In at least two industrial installations, this method is producing sulfuric from waste gases in quantities of commercial importance.

Absorbing in a liquid and then regenerating the solvent by heating is also well known. The solvents used include organic amines, basic aluminum sulfate solution, ammonium sulfite-bisulfite solutions, sodium borate-borid acid solutions, and many others. The large amount of heat necessary to regenerate the solvent, partial oxidation of SO_2 to SO_3, and the large volumes of dust-laden gases which must be handled are the chief disadvantages to this method.

TABLE 1.
PHYSIOLOGICAL EFFECTS OF GASES AND VAPORS SOMETIMES PRESENT IN INDUSTRIAL ATMOSPHERES (CONCENTRATIONS IN PARTS PER MILLION BY VOLUME)

Substance	Formula	First Effects	Threshold Concentration	Dangerous Concentration
Acrolein	CH_2CHCHO	eye irritant	0.5*	150-200
Ammonia	NH_3	throat irritant, edema	100	2,500
Carbon monoxide	CO	headache, heart effect	100	2,000
Chlorine	Cl_2	irritation, edema	1	35-60
Formaldehyde	$HCHO$	eye irritant	5*	20-100
Hydrocarbons, aromatics	C_6H_6	narcosis	35*	10,000
	$C_6H_5CH_3$		200*	
Hydrocarbons, aliphatic, gasolines	C_nH_{2n+2} (n=5 to 7)	narcosis	500*	20,000
Hydrogen chloride	HCl	throat irritant,	5*	1,000
Hydrogen cyanide	HCN	headache, paralysis	10*	100-200
Hydrogen fluoride	HF	throat irritant, mottled teeth	3	50-100
Hydrogen sulfide	H_2S	narcosis	20*	500
Nitrogen oxides	NO, NO_2	irritation, edema	25	100-150
Phosgene	$COCl_2$	lung irritant, edema	1	25
Sulfur dioxide	SO_2	throat and lung irritant	3	50-250
Sulfur trioxide	SO_3	throat irritant	2	10

Another method of commercial importance is neutralization with ammonia. The eventual product is ammonium sulfate, a valuable fertilizer.

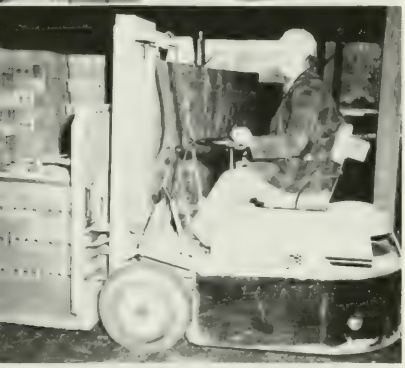
Nitrogen oxides are seldom found in concentrations which are sufficient to be noticed. These compounds are important because they catalyse the oxidation of sulfur dioxide. Nitric oxide (NO_2) is readily soluble in water and can easily be removed from waste gases. Nitrous oxide (NO) reacts with the oxygen of the atmosphere to form nitric oxide. Since the reaction does not go to completion, the oxidation and absorption of nitrous oxide is carried out in a series of steps. Ammonia is seldom allowed to pass into the air because it is very soluble in water and this water solution is of great commercial value.

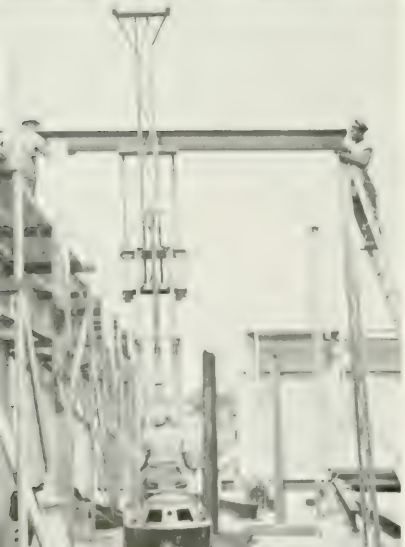
Carbon dioxide concentrations are seldom of any importance. Carbon dioxide must be present to the extent of 0.5 per cent or more before any effect on man is noticeable. At 5 per cent, however, breathing becomes difficult. In closed places carbon monoxide is recognized to be quite dangerous. About 400 *ppm* will produce a headache in two or three hours. In one hour, 0.4 per cent is fatal. Below 100 *ppm*, the gas has no effect. Since both gases are odorless and colorless, they are not considered obnoxious in the open.

Aerosols are suspensions of finely divided particles in air or other gas. Aerosols remain in suspension because their rate of fall is small compared to the Brownian movement or turbulent diffusion. The above definition includes particles, both in liquid and solid, between 0.1 and 100 microns in diameter. When these particles are chiefly water, the aerosol is called fog, mist, or cloud. Smoke is an aerosol consisting of particles formed by combustion. Fumes result from chemical action.

The chemical properties of aerosols are less important than are the physical properties. To most persons, the most important property of an aerosol is its visibility. Sufficient quantities of smoke, fog, or smog to stop auto and air traffic often occur. It may be surprising to learn that the particles do not form an actual barrier against the light

(continued on page 28)





inside industry . . .

with the

(Editor's note: This is the first of a series of articles designed to acquaint you with the many industries in the Midwestern area. Here you will find information, pertinent to you, concerning new industrial developments, a variety of production techniques, products, problems, and job opportunities. We shall bring to you, each month, a different industry encompassing a cross section of all types of industrial development. This is your magazine, so we shall appreciate your requests for information about specific industries.)

The Keyword Expansion

It was in 1929 that C. F. Sweigert brought together three companies, all of which produced logging equipment, into a new organization that has grown to be the world's largest manufacturer of tractor winches and other tractor equipment. The Hyster Company, with over 662 dealer stores in 58 countries of the world, has expanded steadily and soundly to meet the ever-increasing demand for materials handling equipment in this age of optimum production through maximum efficiency. During this evolution, production facilities of Hyster Company have, due to extensive Eastern markets, been extended from the original plant in Portland, Oregon, to include functionally independent plants in Peoria and Danville, Illinois. Continuing this growth, these Hyster plants are currently subject to the largest integrated expansion plan since the founding of the company, which is contrived to increase the overall manufacturing capacity by one third. The Hyster Company is a *carefully* growing organization that will be equipped to produce for peace or preparedness.

The Plant – Danville

Hyster in Danville directly reflects the superior planning and invaluable experience which has been used in designing its materials handling and fabrication arrangement. Opened in 1946, and at this time undergoing major changes designed to utilize the "straight through" production line technique to its fullest advantage, Hyster is an industrial company which offers a wealth of experience to industrial and mechanical engineers who are interested in the latest developments in production control methods. A hint as to the future of the Danville plant may be found in the casual prediction of a Hyster executive that within five years, Danville will house the largest of the Hyster plants. Certainly it seems that any development which will improve materials handling is here to stay—and Hyster is one of the leaders in the materials handling field.

A Product Flexibility

Though the Hyster Company produces a large assortment of equipment for lifting or pulling, the Danville plant is presently restricting production to the 2,000 *lb* and 4,000 *lb* lift trucks, designated QN-20 and YT-40, and the *Salisbury* turret truck. The entire complement of Hyster equipment includes towing winches, worm drive winches, tractor donkeys, tractor cranes, logging arches and sulkies, the *Hystaway* and the grid roller, and an assortment of industrial truck equipment such as fork lift trucks, straddle

Hyster Company

by Al Vejar, gen.e. '53

trucks, turret trucks, and the *Karry Krane*. Each of these basic units has a number of special purpose attachments which greatly increase its flexibility. There are adapters covering a variety of needs, including scoops, booms, aprons, rams, paper-roll and drum handling arms, and, most important, the Load-Grab, which lifts its load by hydraulic side pressure rather than underneath support. It must be emphasized that the accompanying illustrations show a minimum of the infinite potential of uses for Hyster industrial trucks. The extreme usefulness of such materials handling machines is becoming more and more evident in new production techniques, and as industry develops new needs and specialized problems, Hyster is meeting these needs with new attachmnts and more versatile machines. "For any lift or pull' is a slogan which Hyster intends to live up to.

Production—The Preparation

Hyster differs from many industrial plants in that it is almost entirely independent of other than policy controls from the home plant in Portland, Oregon. This necessitates the inclusion of a complete traffic management and purchasing department in the plant which contracts for many of the finished parts and sublets some of the fabrication work. A planning department is also at work to promote optimum production and plan for expansion and reorganization of productive units for greater efficiency. At present, the machine shop at the plant produces approximately one half of the parts necessary to the construction of the lift trucks. The remaining parts are purchased directly by the plant, or, occasionally, purchased by the home plant in a collective buying arrangement and shipped to the subsidiaries by trans-continental, Hyster-owned, trucks. All of the castings making up the lift trucks are contracted for, as are hydraulic equipment, engines, tires, wheels, and some sublet metal fabrication. Finished components, ready for assembly, are brought from the storage area, just within the loading dock, to the central stores area which separates the fabricating and machine shops from the assembly line. Now, let's follow the production of a lift truck all the way through the factory.

Fabrication and Stores

The production flow of this plant is almost a "U," with the three truck-receiving dock, including storage area, and railway supply spur both entering one side of this "U." Material from the loading dock is moved, by overhead crane and lift truck, into the machine shop which is comprised of the "casting machine shop" where all unfinished castings are prepared, and the "bar stock machine shop" where an automatic turret lathe and manually operated lathes reduce bar stock to finished parts. This side of the plant also houses the welding and cutting equipment used in fabricating the frames and counterbalances for the trucks. Here, in the "plate shop," cutting torches bite through slabs of metal over six *in* thick, allowing the use of cut and welded, rather than cast, counterbalances. In this shop the welding sub-assembly is completed and the truck begins to take form. It then enters the spray room for a coat of primer before passing on to the central stores area.

Central stores, as the name suggests, is the middle section of the "U," housing all the parts and sub-assemblies which will be distributed to the assembly line. Also included in this area is the shipping dock with crating facilities and railway loading spur. The utility of this area's function may readily be seen when we consider the production technique used by Hyster. Both models of lift truck, YT-40 and QN-20, are produced by the same assembly line. Though this might suggest a waste of time and manpower due to altering the assembly line to run the different products, not one truck is lost in the change-over. Here, Hyster capitalizes upon materials handling economy. Since Hyster lift trucks are constructed in production orders of 100, the central stores area pre-polls parts into bins so that the specific number of parts to complete the run of one hundred is included in these bins. These pre-stocked bins are moved to the various assembly points and, as the model of truck is changed, it is only necessary to remove a rack of bins and substitute the bins containing the new parts as the last model of the series passes the individual station. Hyster lift trucks can switch these bins quite readily. In this manner eight YT-40s or eleven QN-20s are produced daily.

The Assembly Line

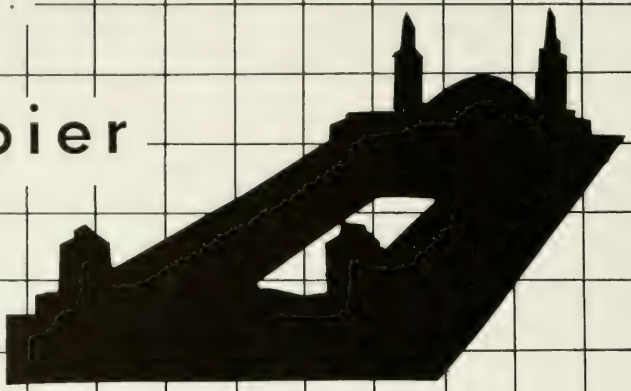
Here is assembly, the six-stage operation that turns the effort and ability of many men into a functional reality.

(*continued on page 24*)

An air pump can easily be hung on the side of a locomotive using the Hyster forks. (Courtesy of Hyster Co.)

— the university of illinois at . . .

navy pier



by Warren H. Brandt, c.e. '54

Harvard on the rocks

From *American Highways* for July comes this discussion of ancient surveying and construction procedures:

The "old man" came into the office just as a surveying party was starting out. "When you boys come back," he said, "I will show you a translation of that Egyptian document, written on papyrus, about 4,000 years ago. It is a report to the Pharoah of that time."

This was the translation:

"Know, O mighty Pharoah, that I have made inspection of the works of the upper Nile. I found the builders to be a most strange breed. First cometh men with a three-legged prong with which they make divers observations. When they approach a village the maidens fleeth and the villagers bewail exceedingly because they always aim the prong at a house saying "it must be moved," although the desert stretcheth for miles around desolate. Sometimes the prong men drive little stakes in the ground. They play a game and wait until someone knocks down one of the stakes, and then the prong men jump up in the air and shout and tear their hair and call on Ra and Osiris and Isis and Horos an all the lesser gods, and they become exceedingly wroth. All about a little stick. They also make many hieroglyphics, many of which they themselves do not understand.

"Then cometh the contractors. They are a class that have many possessions and ride in fine chariots, but they easily run to bitter tears, and they runneth down the work to be done, to each other that they may make the other afraid and he add much expense to his calculations.

"Then cometh the material men clad in fine raiment and the maidens meet them with gleeful smiles, as they have something magic called an "expense account." They are all worshippers of the Sacred Bull. Every morning they chant "O Sacred Bull, keep us full of thy substance because only with thee can we make our living."

"Then cometh the letting of the contract. Whereat one contractor draws the prize, and the rest of the contractors beat their breast and pour ashes on their heads, and say with a mighty shout, "He can't do it for the money." Always have they said this, and always to the end of time will they say it, even until the stars grow cold.

"But the low bidder he smiles and is pleased with himself, wise in his own conceit, and he hunteth up the three-prong men and taketh them to dine with him, and handeth the check to a material man."

ENGINEERING SOCIETIES

A S C E

At their November meeting the members of the student chapter American Society of Civil Engineers heard Mr. Gary Cass, former Pierite, and now an engineer with Universal Concrete Form Company discuss the "Use of Uni-form Accessories in Concrete Form Work." Mr. Cass also presented an interesting movie illustrating Uni-form accesories in use on such prominent construction jobs as the Wacker Drive Extension and the Caribe Hilton, a luxurious hotel in the West Indies. The accessories are adaptable to all types of concrete work and the introduction of these devices should prove valuable to those civils interested in construction work.

A I E E

Professor J. D. Ryder, head of the electrical engineering department on the Urbana campus presented an enlightening discussion on "High Speed Digital Computers" before the November assembly of the Student Chapter, American Institute of Electrical Engineers.

At their December meeting the EE's will hear Mr. J. C. Foss, station design engineer, Commonwealth Edison Co. speak on the New Ridgeland Generating Station, an enormous power station constructed on Chicago's Southwest side.

S A M E

Newest of engineering societies on the Chicago campus is the Society of American Military Engineers, accepted into the senior branch at a formal meeting-banquet October 25.

Officers of the Society are Clifton Zabka, president; Richard Krammerer, vice president and treasurer; John Curtis, secretary and George Hunt, program chairman.

The Society has as its purpose the acquainting of the members with contemporary military engineering projects.

The Society's magazine, *The Military Engineer*, is an outstanding one

(continued on page 34)

behind the grill cloth

by Bob Quick, e.ph. '54

(concluded from last issue)

Once the loudspeaker is designed and manufactured, it becomes necessary to couple the moving cone to the surrounding air. If the radiation from the reverse side of the cone is presented a path to the forward side less than a wavelength in extent, destructive cancellation will ensue, resulting in diminished acoustic output. This means that at moderately low frequencies some method of separating front and back radiation must be provided.

In general, baffles may be considered as falling into two classifications: the infinite baffle, with its almost infinite number of variations, and the horn. The infinite baffle attempts to separate the front and back radiation, either allowing one half the energy to be dissipated, unused, in a separate chamber or body of air, or in the many, more familiar forms of baffles, to reinforce the front radiation by delaying the rear radiation and introducing it, at the proper time, and in the proper phase, to augment the sound intensity. A true infinite baffle is seldom seen, however, since for low frequencies, a baffle radius of the order of 15 or 20 *ft* is indicated. The usual approach to this is to mount the speaker in a wall. This is not always practicable, however, and the search for a compact baffle has brought forth a number of designs, probably the most notable being the bass-reflex enclosure.

The bass-reflex enclosure is a highly specialized development resulting from the attempts to condense the size of the infinite baffle. It is not an infinite baffle nor does it closely approximate one. The principle upon which it operates is rather simple to explain in general terms, but mathematical development of the formulae defining its parameters is quite another matter. Shortly before the point at which low frequency response begins to fall off, there is a rise in speaker sensitivity at the resonant frequency of the assemblage. This resonant response peak is utilized in connection with a resonant column of air in the bass-reflex enclosure. The resonances of the two cancel, the speaker cone becomes effectively coupled to the air, and the port, situated close to the speaker, becomes the virtual source of the sound waves. By means of this artifice, low frequency sound output may be extended about an octave. Below this point, however, the response drops off, thus necessitating the choice of a speaker with a low resonant frequency to begin with. Furthermore, improvement in performance is rather problematical unless the cabinet is designed expressly for the specific loud speaker with which it is to be used. For the casual or home constructor, the data necessary to design such a cabinet is usually unobtainable, unless a small laboratory is at his disposal. In the usual case, good results are to be obtained only when the cabinet has been experimentally developed for a specific application, usually by the speaker manufacturer.

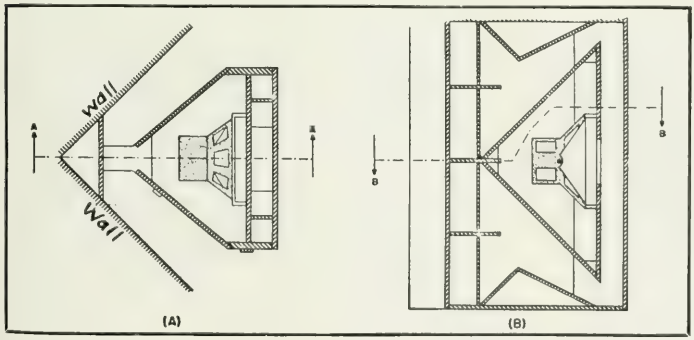
Understandably, then, the bass-reflex enclosure is somewhat of a makeshift device, a "two-wrongs-make-a-right" proposition, but it still has much to recommend its acceptance. The construction is simple and economical, the cabinet is of a tasteful shape and practical size, and is readily disposed harmoniously amidst the *décor* of almost any room. This is more than can be said of many of the other methods of baffling.

The horn is more to be considered an acoustic transformer rather than a baffle. By effecting the transformation of acoustic power in a high pressure, low volume current state at the throat of the horn, where it is coupled to a relatively heavy vibrating source, the speaker; to a low pressure, high volume current state at the mouth, where it is coupled to a relatively light vibrating medium, air, which acts as the load, it is seen that the horn is, primarily, an impedance matching device. Proper selection of horn parameters enables the design of units for a number of different purposes, although the most common use is for high power speech reinforcement or reproduction where the attendant increase in speaker efficiency and power sensitivity affords a considerable reduction in expensive amplifier power. Particularly for open air use, the variable directional characteristics of a horn permit the economical use of sound power.

There are five types of horns; classified by their flare, they are: the conical,

(continued on page 30)

Rear three-quarter view showing interior detail of a folded, exponential corner horn of the modified Klipsch type constructed by Dean Everitt. (Courtesy of Wilson C. Stone).



Vertical and lateral sections of the Klipschorn. A comparison of the two illustrations will reveal the added stiffness chamber at the rear of the modified horn. (Courtesy of Radio and Television News).

skimming industrial headlines

edited by Howie Hadler, ag.e. '54

radar routs poachers

Radar, the restless electronic eye that sees through miles of fog or darkness, is driving illegal fishing from the coast of California.

Since the California Fish and Game division installed radar on one of their patrol boats, the Albacore, in 1949, the number of boat arrests has more than doubled.

Prior to the installation of the radar apparatus, fish poaching within the California coast's three-mile limit was relatively easy. Illegal fishermen were not the least bit leary of entering closed fishing areas whenever fog or darkness descended. The standard operating procedure of patrolmen was to stop the boat engines and listen for the engines of poacher boats, or wait for a careless poacher to show a light, or light a cigarette on deck.

One dark night recently, a patrol captain didn't see a poacher until the patrol boat's spotlight hit him after radar had guided the craft within a yard of the poacher's boat.

So far, there has been only one boat arrest this year, due to the effectiveness of the radar system making poaching too great a risk to attempt. Violations of the conservation law are becoming extremely rare, and it is thought that in a few years poaching along the California coastline will be something of the past, thanks to the probing eye of radar.

artificial respiration for jets

Starting jet engines by "artificial respiration" has been tested recently in Korea. The method, in which exhaust blast from one jet is used to start another directly behind it, seems to be a practical means of starting jet aircraft at advance bases where external power units are unavailable, or in extremely cold weather where effectiveness of such starting sources is reduced. Because of the large amount of power required, jet aircraft usually rely upon field power units for starting, rather than their own electrical systems.

The tailpipe of an operating jet is aligned directly in front and some distance ahead of the air intake of the plane to be started. When the engine of the lead plane is accelerated to full power, the exhaust blast is sufficient to windmill the power plant of the starting aircraft to more than initial firing speed and a normal start is made.

This method of starting jets saves many planes which have inoperative battery systems or have no access to external power units, since these planes would otherwise have to be abandoned and might fall into enemy hands.

adjustable-voltage control

Crane controls so sensitive they can regulate the movement of a 250-ton load to within one thirty-second of an inch were tested recently by the U. S. Army Corps of Engineers at McNary dam on the Columbia river near Umatilla, Oregon.

Developed by Westinghouse, the new adjustable-voltage control has been installed on the first of two massive 200-ton gantry cranes for the dam. These cranes will be used to raise and lower the 126-ton spillway gates at the dam. When a gate is raised, the load on the crane approaches twice the weight of the gate, because of the downward pressure of the water rushing under it.

Each crane is 60 *ft* long, 42 *ft* wide, and towers 77 *ft* above the top of the dam. Mounted on 16 wheels, the giant cranes move along the top of the dam on rails placed 34 *ft* apart.

The adjustable-voltage control embodies speed-torque characteristics that inherently cause the motor to slow down in both the hoisting and lowering cycle when the load is increased, without change in the setting of the control. The control monitors or measures the load on the motor, and adjusts the speed accordingly. The system provides a stalling torque of 200 per cent of full-load torque, thus limiting maximum mechanical and electrical stresses.

The d-c motors for the main hoist, trolley, and bridge drives are powered through a four-unit motor-generator set mounted in the machinery house on top of each crane. The set converts 440-volt a-c power to direct current power.

(*continued on page 36*)

Patrol boats equipped with radar stop fish poaching along the coast of California. (Courtesy of General Electric).

Jet engines may now be started by an "artificial respiration" system without the aid of booster systems for power. (Courtesy of General Electric).

a new tool in agricultural research . . .

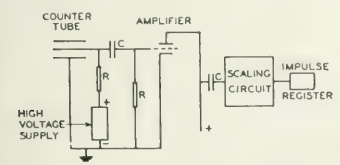
radioactive phosphorus

by John Anderson, ag.e. '53

Terms like atom, electron, atomic pile, and radioactivity are quickly associated with mass destruction, people killed, and homes burned. This is a logical assumption because many people had never been exposed to such terminology until after the United States dropped the atomic bomb on Japan. It was at this time that papers and magazines started an "understand the atomic bomb theory" movement. For years after the first atomic explosion, many scientists published their own simplified explanation of how atomic energy had been used to blow up cities, how radioactive burns have caused death, and even the theory of how the atomic bomb may cause the end of the earth. As we look back at this first great trend in atomic interest, it is easy to see why the average person associates atomic energy with the atom bomb.

Within the last few years a new topic in the field of atomic research has become popular, namely the study of radioactive tracers. This project is not designed to develop a new form of destruction, but is going to produce a material that will be beneficial to all mankind.

Radioactive tracers are just what the name implies, radioactive materials that can be traced or followed throughout any movement or reaction. The tracing of the movement and amount of certain atoms in the plant-soil relationship is the main object in the study of radioactive tracers with relation to agriculture. Chemistry has contributed greatly to the improvement of scientific agriculture, but chemical analysis alone does not possess the competence that is found in the tracer method. A plant can be chemically analyzed for its phosphorus content, but the plant itself must be burned. This procedure is complicated and not always accurate. With the use of radioactive phosphorus as a tracer, the quantity of phosphorus in a plant can be determined accurately and simply by using a Geiger-Mueller counter. The phosphorus from a fertilizer can be distinguished from that taken from the soil. The rate of absorption can be studied because the plant is not destroyed to obtain an analysis. The advantages of the tracer technique may make it possible to formulate answers to many fundamental problems which hold the key to some of nature's guarded secrets.



Block diagram of counting circuit, using a scaling circuit and mechanical impulse recorder. (Courtesy of SSSA).

Until now, the widest and most comprehensive tracer research in agriculture has been performed with radioactive phosphorus. The preference is probably due to many reasons, but mainly because phosphorus is a necessary element for plant and animal existence. Another factor that makes radioactive phosphorus a desirable tracer is that it has a desirable half-life (14.3 days), which means that half of the phosphorus will be disintegrated in 14.3 days.

JOHN ANDERSON

Born in Rockford, Ill., John is a product of East Rockford High School.

At Illinois, John is a junior in agricultural engineering. Since he is a member of the AFROTC, his future plans depend upon Uncle Sam.

John, besides being an assistant business manager on the TECH, is a member of ASAE and is serving on a committee at the McKinley Foundation.

The radioactive tracer method is based on the fact that a certain isotope of phosphorus will actually explode and change form. During this change in form, some minute particles are released to move freely along their own paths. The detection of these particles with the Geiger-Mueller counter is the basis of the tracer analysis.

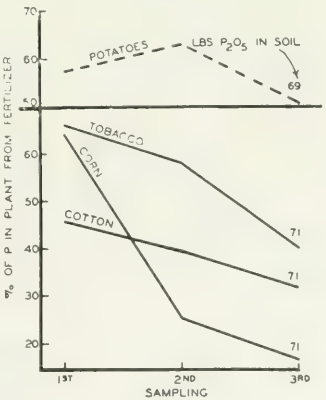
There are two common methods used in tracer research to record the radiant energy emitted from the exploding isotope. The Geiger-Mueller counter will "click" every time a radioactive isotope explodes in its presence; therefore, by recording the number of clicks, it is possible to calculate the amount of radioactive material in one location. When a special film is exposed to radioactive radiations, a picture revealing the position of the radioactive material will form on the film. The picture produced in this manner is called an autoradiograph.

The production of radioactive elements by the cyclotron, in 1936, made possible the use of radioactive phosphorus in research. A group of scientists (Hevesy, Linderstrom, Lang, and Olsen) was the first to make use of the opportunity of obtaining radioactive phosphorus isotopes. They made a few experiments with plants and studied the abilities of the tracer. The production of radioisotopes from the cyclotron was slow and costly; consequently, the advancement of tracer research was limited to only 33 different studies in the ten year period between 1936-1946.

During World War II, the United States Government developed an atomic pile of uranium and carbon at Oak Ridge, Tennessee. By exposing a neutral element such as sulphur to a neutron stream in the pile, it was possible to obtain a radioisotope of the element. It was not until 1946 that the first radioisotopes of phosphorus from Oak Ridge were made available for nonmilitary research. With a method to produce radioactive phosphorus at a reasonable cost and in quantity, tracer research expanded with surprising speed.

In the United States, two radioactive phosphorus research programs have been set up. One is a co-operative program sponsored by the fertilizer industry. The other program is supported by the government. The two systems share re-

(*continued on page 20*)



Percentage of phosphorus absorbed from fertilizer by tobacco, corn, and cotton at three stages of growth. (Courtesy of SSSA).

honorary and society news

by Mel Rudich, gen.e. '53

MIS

One of the more recent engineering societies is the Mineral Industries Society, a student association of the American Institute of Mining and Metallurgical Engineers.

This semester MIS started off with its annual smoker which was held at the Illini Union on October 3. The purpose of this meeting was to acquaint the freshmen and transfer students with the members of the society and to offer them an opportunity to meet their instructors on an informal basis. H. L. Walker, head of the department of mining and metallurgy, then introduced the various department instructors. Coffee and donuts were then served and everyone had a very enjoyable time.

The first business meeting of the year was held on October 10, at which time the movie "Copper" was shown on the processes involved in the mining and refinement of copper as practiced by the Anaconda Copper Company. After the film the following officers were elected for the fall semester: Daryl Gaumer, president; Richard McClintick, vice president; Warren Holland, secretary; and Robert Pounds, treasurer.

At present the only active committee is the Program and Publicity Committee headed by Chairman Len Austin. Plans and committee appointments are being formulated by the officers of MIS for the Open House next March.

CHI EPSILON

Chi Epsilon was formed as a national civil engineering honorary at the University of Illinois in 1922. The objective of Chi Epsilon is to increase the effectiveness of the civil engineering profession as an instrument of social betterment. Active members are selected on the basis of scholarship, character, practibility, and sociability—the four requirements of a successful engineer.

Active membership is open to all students registered in the civil engineering and associated curriculum who are ranked as juniors or seniors in regular standing and who have maintained a grade in scholarship in the upper one third of their class. However, it has been the precedent of the Alpha Chapter to pledge only juniors and seniors in civil and general engineering with a grade point average of 4.0 or better.

The publication of *The Benchmark*, a monthly newspaper for civil engineering students, monthly luncheons, business meetings, initiation of pledges, and the initiation banquet are a few of the many Chi Epsilon activities here on the campus.

Bob King, varsity end coach of the Illini football team, gave a very interesting talk on football at the October luncheon, and Professor J. E. Cribbet was the speaker at the November luncheon.

Members initiated at the December 5 initiation banquet were as follows: Louis Baucher, Ronald Beach, Charles Beilfuss, Tien-Sun-Chang, Dean Compher, George Conlee, Harold Honath, John Kaya, John Landgren, Norman Latker, James Lubin, Khalid Mahmoud, William Richardson, Leroy Ruesch, William Schnobrich, Walter Stanke, Robert Stoll, Alfred Tarabori, Robert Watson and Tom Willette.

Officers for the fall semester are Pete Kuhns, president; John Jombock, vice president; Harry Hillman, secretary; Stamley Rupiper, corresponding secretary; Henri Cowger, treasurer.

AIEE-IRE

On October 18 and 19 the AIEE-IRE sponsored Paul W. Klipsch of Klipsch and Associates, Hope, Ark. Mr. Klipsch has developed a corner speaker called the Klipschorn and he gave two talks concerning it. The first was a nontechnical talk and demonstration given at Smith Music Hall. The second talk was technical and was given at the EE graduate seminar in 100 Physics Lab. At the October 30 meeting Mr. Carl Miller of Weston Electrical Instrument Corporation gave a lecture demonstration entitled "Behind the Instrument Dial." The lecture concerned the construction and movements of the basic electrical measuring instruments, the ammeter, voltmeter, and wattmeter. Instruments in plastic cases were exhibited showing internal detail and actual operation.

On November 8th, Alfred Crosley and Walter Wallin of Alfred Crosley and Associates of Chicago displayed their exhibit of newly developed electronic instruments. After the meeting the exhibit was open for public inspection in 138 and 146 EEB.

The December meeting of the AIEE-IRE was held at 7:30 p.m. in 138 EEB December 13. Mr. Arthur L. Riche, vice president, Micro Switch Division of the First Industrial Corporation, Freeport, Ill., was the speaker. His subject was "Micro Switches."

ASCE

At the October 11 meeting of the student branch of ASCE, Professor Guillou of the hydraulic department, gave an illustrated talk on "Scouring Behind Bridges." Highlights of his talk were emphasized by slides of bridges near Shelbyville. Professor Richardson, architect, gave a talk, "The Growing Importance of Civil Engineering in Architecture" at the November 13 meeting.

IES

The Illuminating Engineering Society is composed of illuminating engineering majors, illumination faculty, and any architects who are interested in the rapidly progressing field of illuminating engineering. After their business meetings, the IES have a speaker from one of the various larger industrial corporations. Mr. B. Lazerson, engineer for the Solar Lighting Company, presented an interesting talk, accompanied with color slides, about the modern store and school lighting that are being installed in Chicago.

A man recently had a new house built. Inspecting it, he concluded that it didn't look very strong. He mentioned it to the architect.

"Well, after all," replied the architect, "you've got to consider that we haven't got the wallpaper on yet."

For engineers who like challenging work

Meeting this country's civilian and military production needs is providing an endless variety of problems to challenge the best of engineering brains.

Here at Western Electric, as in all big manufacturing concerns, the job calls for the pooling of special skills by mechanical, electrical, industrial, chemical, metallurgical and other engineers—to come up with the right answers.

The primary job at Western Electric—the manufacturing unit of the Bell System—is to make the thousands of kinds of telephone equipment needed to keep this country's telephone service going and growing. Many of these products are so tiny or so unbelievably complex—calling for such precision—that you'd think they could be made only by skilled technicians working under closely controlled *laboratory* conditions. Yet Western Electric engineers devise machines and techniques which enable workers, after a short training period, to turn these things out under *factory* conditions. There's a real kick in doing work like that!

And, because of the specialized experience gained in our regular telephone job, Western Electric is also working on many important communications and electronic equipment projects for the Armed Forces. Such things as radar fire control systems for the Navy's biggest guns and for anti-aircraft guns—radar bombing systems for America's largest planes—multi-channel radio sets for all types of military aircraft—electronic marvels to launch, guide, and explode the latest guided missiles—provide opportunities galore for creative production planning.

Both of Western Electric's jobs—telephone and military—are vital to this country's present and future strength. Both are filled with challenges for the best engineers of today and tomorrow.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

by Bob Schrader, ch.e. '54 and John Huber, ag.e. '52

Last Minute Cramming

There's an exam coming up tomorrow so like all good engineers my roommate and I are exerting ourselves to the utmost in preparation. I'll admit it is a little hard to concentrate with that Esquire calendar leering at me from the middle of our muddled table. Amazing, isn't it, how she can be so discreetly clothed with two long black gloves.

Dragging my eyes back to the open TAM text I pry out a confusing question and fire it at my roommate. I have to fire it with quite a loud report for he is in his normal position (normal to the wall) and is playing one of his Errol Garner records. I keep telling him how it sounds like banquet music and every time I do he noisily blows his stacks. It really does sound like banquet music though—don't know why my saying so upsets him.

Anyway, he finally turns down the volume and I repeat the question. By this time I've forgotten the answer I wanted so while he is dissertating to great length on why the frictional force does no work on a non-slipping, rolling body I turn my attention to our belching radiator in the corner. We've nicknamed it "Mt. Vesuvius" for obvious reasons. The value is broke so whenever we want some heat (and when don't we?) we just unscrew the plug and let the steam spew out. There is some discussion as to what stage its eruptions typify. I say it is in the Strombollian phase because it doesn't crust over between eruptions but just expels steam. My roommate however maintains it is in the Pelean phase because of its long periods of dormancy. (These dormant periods occur on cold days when we have no classes so we usually have to run outdoors fairly often and roll in the snow to get warm.)

Without the plug, which has mysteriously disappeared, "Mt. Vesuvius" disgorges enormous amounts of steam. This steam has a marked effect on the wallpaper on that side of the room and the plaster also seems to be weakening. The room's humidity is somewhere in the nineties and we are trying to decide whether to dry it out by having a truckload of calcium chloride dumped in the corner or just toss a handfull of dry ice toward the ceiling and let precipitation take its course. We're afraid though that

JOHN HUBER

this latter method would produce freezing rain and make it very difficult to get in bed. Ever try to sleep under an ice blanket?

Dear roommate has finished his answer to my question, whatever it was, and has promptly fallen asleep. Guess it's up to me to get my knowledge alone now. Let's see, a point on a cylinder rolling down a plane moves along a cycloidal path, therefore, the frictional force is . . . acting . . . and those black gloves go good with her blonde hair—about the same shade as that one's last night. Wonder what she's doing now . . . mighty nice last night . . . yes indeed . . . like the way she . . .

The Christmas holidays always seem to be a time for reviewing the past year and also for looking ahead. The *Bilge* hereby takes an end-of-the-year look into the future. What year shall we look at? George Orwell picked 1984, so that should be good enough for us. Without further ado, *Boneyard Bilge* presents the Highlights of 1984 on the Engineering Campus:

JANUARY

The return to school following Christmas vacation was postponed for a day as the Fighting Illini were playing in the Kangaroo bowl at Melbourne, Australia. The University airport was alerted to handle the influx of jetmobiles carrying students coming directly to school from Melbourne. Engineering campus went wild celebrating the victory over the University of Melbourne. Instructors refused to hold class for three days. "Let's give the boys a chance to celebrate" was the general opinion.

FEBRUARY

This year the University tried out its new system of final exams. Instead of writing finals, students used headpieces especially developed by the U. of I. These headpieces analyzed the student's brain waves to find out how much he knew about a course. This plan was a failure, though. A PE major accidently stuck his head in an engineering physics headpiece and short-circuited the whole system.

MARCH

As a novelty this year, St. Pat's Ball was held as a tribal dance in the Belgian Congo. The dance started at the

(*continued on page* 38)

This is a magnification of what abrasive material?

- ☐ *Commercial Diamond*
- ☐ *Fused Silicon Carbide*
- ☐ *Fused Aluminum Oxide*
- ☐ *Boron Carbide*

The answer "Fused Aluminum Oxide" gives you a passing mark. But, it's not just ordinary fused alumina. It's Norton 32 ALUNDUM* abrasive in a single crystal, containing more than 99% pure fused alumina — hailed as the "greatest abrasive contribution to increased grinding production in more than 40 years."

How It's Made

When bauxite is submitted to an extremely high temperature in an electric furnace by an ingenious Norton Process, grains of 32 ALUNDUM abrasive form in a fluid matrix where each grain grows into a single, complete crystal — strong in shape and with many sharp points on all sides. The matrix not only contributes to 32 ALUNDUM abrasive's unique crystalline structure but also absorbs impurities from the melt. This accounts for the better than 99% purity.

The matrix is then dissolved away by a complicated chemical process and the released grains are washed and screened to size. No crushing is necessary.

Amazingly Versatile!

The extra sharpness and crystalline form of Norton 32 ALUNDUM abrasive enables it to grind cast iron, aluminum, bronze, brass, soft steel, high-speed steel and cast alloy tool materials. Its versatility is further borne out by a typical report. In one prominent plant, Norton 32 ALUNDUM wheels, replacing other wheels, accounted for over-all time savings, floor to floor, of: surface grinding — 26.3%; internal grinding — 13.1%; tool grinding — 13.2%; cylindrical grinding — 25%.

Worth Remembering

This example of "making better products to make other products better" promises an interesting future to young engineers who want to contribute to new developments. Norton Research is well worth investigating.

Free Folder

highlights the cost-cutting advantages of Norton 32 ALUNDUM abrasive on countless grinding jobs. Write for your copy.

Gordon R. Finlay, Ph.D., Cornell '42, examines a specimen with the Metallograph in the Physical Testing Laboratory at the Norton electric furnace plant in Chippawa, Canada.

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PHOSPHORUS . . .

(continued from page 18)

salts obtained and are not trying to compete.

The fertilizer industry has a Phosphate Research committee with V. Sanchelli as its chairman. This committee received $19,000 in 1947 from voluntary contributions given by 30 companies in the fertilizer industry. The money was given "exclusively to sponsor joint industry-experimental station research projects employing the radioactive tracer technique for the solution of fundamental problems in soil-plant fertilizer relationships."

The government tracer research program is operated by a combination of the United States Department of Agriculture and many individual state research stations. The USDA, with headquarters at Beltsville, Maryland, was the first to start the expansion of radioactive phosphorus research. In 1947, five men worked with radiophosphorus in the research laboratory at Beltsville. In 1948, twenty-five men were working at Beltsville alone, while the program was functioning in fifteen different states. Another example of the sudden expansion can be seen from the increase in the use of radioactive superphosphate. In 1947, 100 *lbs* were used; in 1948, 700 *lbs*, and in 1949, 1,100 *lbs* of tracer material were used throughout the country.

The phosphate research performed with radioactive tracers can be divided into three groups as follows: the study of fertilizer application in relation to plants and soils, the study of plant distribution of phosphorus, and the study of phosphorus metabolism in animals. These divisions are not strictly individual because some experiments will fall into all three groups.

The use of radioactive phosphorus as a tracer in the study of fertilizer application is by far the most popular of the three groups. The demand for commercial phosphate fertilizer is increasing yearly. In 1947, the country spent $758,000,000 for 17,000,000 tons of fertilizer. It is easy to see that this extra cost will reflect in the price of food bought at the neighborhood store; therefore, the fertilizer problems should be everyone's concern. The factor causing the big research demand is that a very low per cent of this large amount of phosphate fertilizer applied to the soil is consumed by the farm crops. Experiments with radiophosphorus have proven this fact, and it is hoped that with the help of radioactive phosphorus tracers, new methods to improve the efficiency of fertilizers can be found.

The tracer methods used to find the per cent of phosphorus absorbed by a plant from a fertilizer are fairly simple and easy to understand. The procedure used in an experiment to determine the phosphorus absorption of oat plants will illustrate this point.

A good grade of soil was measured into a jar, and a dozen oat seeds were planted in a circle around the inside of the jar. When the plants were about two *in* high, a measured amount of radioactive phosphorus solution was added to the soil in the middle of the circle formed by the oat plants. When the oats were ripe, they were harvested and the amount of radioactive phosphorus present in the oats was recorded by a Geiger-Mueller counter. By comparing the number of clicks per minute recorded when the oat heads were in contact with the counter to the number of clicks per minute recorded from a volume of the original solution, it was possible to calculate that 33 per cent of the phosphorus applied was absorbed by the oat plants.

If tracer experiments of this type are performed with many different farm crops, it may be possible to reveal that the amount of fertilizer left unused by one crop may be partially recovered by different crops.

Radioactive phosphorus tracers are being used to find the reason why farm crops make use of only a small per cent of the applied fertilizer, and how today's fertilizing methods can be improved. This research project can be divided into the solution of three problems: what per cent of phosphorus is fixed in the soil and how it is possible to lower this percentage; where is the best location to apply the fertilizer with relation to the plant; and in what fertilizer composition does the phosphorus best make itself useful for plant absorption? It will take many years of research to formulate absolute answers for the problems, but the work has begun already. Some radioactive phosphorus experiments have shown their importance by recording definite figures relating to certain reactions.

Phosphorus fixation in the soil causes the loss of a large amount of fertilizer. The fixation occurs when certain soil materials bind the phosphorus in a water insoluble state which is not readily available for plant absorption. With the use of radiophosphorus, it is possible to study the rate of this fixation in different soils.

The following experiment is an example of the methods used in this study. A small amount of radioactive phosphorus was combined into a fertilizer compound, and with a Geiger-Mueller counter the number of radiations per minute was recorded in a solution of the fertilizer. The fertilizer solution was then shaken with a certain type of soil. The mixture was filtered and the filtrate tested with the counter. The difference between the count of the original solution and the filtrate would reveal the per cent of phosphorus fixed by the soil. Similar experiments performed on different soil types revealed that (varying with soil composition) from 20 to 95 per cent of phosphorus fertilizer is fixed by the soil. The fixation experiments also revealed that the small amount of fluorine present in commercial fertilizers has a tendency to increase the phosphorus fixation.

The second important problem to be solved in the realm of commercial phosphate fertilizer is the placement of the fertilizer for best results. Radioactive tracers have also been a great aid to the solution of this problem. In the general method used in an experiment of this kind, radioactive phosphorus fertilizer was placed in soil at different locations with respect to the plant. The amount of phosphorus absorbed by the plant from the different placements can be found by the use of a geiger-Mueller counter arrangement. Many interesting facts have been revealed by this type of experiment. For example, a tracer experiment with sugar beets showed that fertilizers placed only four *in* away from the seed were not found in the plant until it had grown five *in* high. The sugar beet needs the fertilizer at a much younger stage than when it is five *in* high. It was found (in contrast to the beet experiment) that fertilizer placed too close to the potato seed damaged the young root; therefore, potato fertilizer would be more efficient if placed five *in* away from the seed.

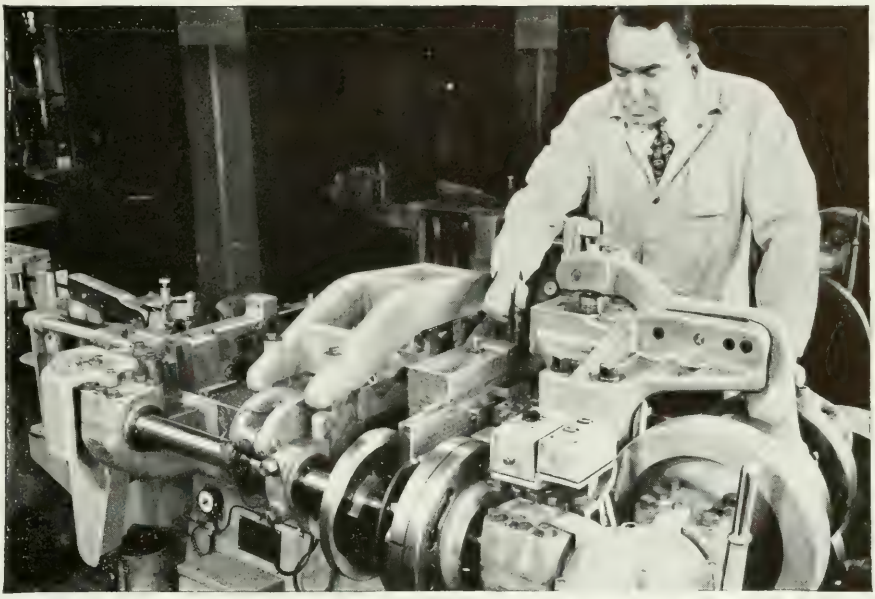
An increasing number of experiments are being performed with different types of phosphate fertilizer. An experiment with superphosphate fertilizer and TVA phosphate fertilizers treated with radioactive tracers was performed in Iowa. The results revealed that plants consumed a slightly higher per cent from the superphosphate mixture. In a greenhouse, the utilization of phosphorus from manure was being studied. The experiment was performed fairly simply with manure from sheep which had been fed a radioactive phosphorus compound.

In the near future, tracer tests will be able to tell the farmer how, when, and where to place his fertilizer so it will have the most effective and efficient results on each farm crop.

Radioactive phosphorus tracers have been used in any studies relating to plant consumption and distribution of phosphorus. These studies are very important because they reveal during what period a certain plant consumes the greatest amount of phosphorus, how each plant distributes its phosphorus, and how certain plant diseases injure plant tissue.

(continued on page 42)

FLAT SPRING STEEL



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Only STEEL can do

MISSION OF MERCY. Here, a Naval medical officer is being hoisted aboard a helicopter to bring quick medical aid to an injured sailor on another ship. All-out defense requires vast quantities of steel. And U.S. Steel's capacity, far larger now than ever before, is being still further expanded to help meet both defense and everyday needs.

WHEN TIN ISN'T TIN. This young man's baby food comes to him perfectly protected against contamination by airtight "tin" cans. But those tin cans are really *steel* cans . . . about 97% steel, with a very thin coating of tin. And U.S. Steel makes thousands of tons of tin plate every year to be used in forming billions of cans to safeguard food, oil, paint, and other items.

SIPHON WITH A STEEL THROAT. Extending around the north end of Soap Lake in the Grand Coulee area, this huge siphon, more than 22 feet in diameter, will carry irrigation water from an elevation of 1329 feet down into a 215-foot dip in the land's profile, and up again to an elevation of 1301 feet. The siphon is steel-lined concrete pipe. The 3400 tons of steel plate used to fabricate the liner sections were supplied by U.S. Steel, while the outside traveler and form (inset) and the inside traveler and collapsible ribs, were especially fabricated by U.S. Steel for the casting of this large conduit.

Listen to . . . The Theatre Guild on the Air, presented every Sunday evening by United States Steel, National Broadcasting Company, coast-to-coast network. Consult your newspaper for time and station.

AMERICAN BRIDGE COMPANY • AMERICAN STEEL & WIRE COMPANY and CYCLONE FENCE DIVISION • COLUMBIA STEEL COMPANY • CONSOLIDATED WESTERN
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EASY ON THE BACK. When it comes to shoveling snow, you'll agree that this machine is a great improvement over the old hand shovel. Just as U·S S COR-TEN Steel, of which it is made, is a great improvement, for many purposes, over ordinary steel. For COR-TEN permits equipment like this to be built *lighter*, and yet to possess the great strength and rugged resistance to abrasion and corrosion essential for satisfactory performance. Only steel can do so many jobs so well.

MODERN MAILING ROOM. Ever wonder how all those millions of magazines that are printed every month in America are packaged for shipment? Many of them are tied into wrapped bundles with Gerrard Round Steel Strapping, made by U.S. Steel—on Gerrard Model Q semi-automatic tying machines like these.

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Steel costs less than every other metal in the world. It is cheaper per pound than the cheapest material from which clothing is made. It is cheaper than the lumber that goes into your home. It is even cheaper than the pulp upon which your daily newspaper is printed.

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HYSTER COMPANY . . .

(continued from page 11)

The remaining half side of the "U" is devoted to this operation. The first step of final assembly begins when the trunnion counterweight is brought in from the outside storage stacks and set upon the dolly which carries it down the assembly line. At this station, the hydraulic package unit is installed, and the frame is lowered over the entire unit. The muffler, gas tank, rear wheels, axle, motor bracket, generator, and fire-extinguisher are also mounted on the frame here. Now on to station number two. On the production line, right by station two, the sub-assembly of the hydraulic tank and valve is carried on. Station two then installs this unit, plus the tilt cylinder, and connects the hydraulic unit installed at station one. Another sub-assembly is connected with station three. The complete power unit, motor, clutch, and transmission is built on its own assembly line intersecting the main line at right angles. A complete test is run during this sub-assembly operation, and the power unit is approved before installation. This power unit is installed at station three, where dash unit, wiring, horn, differential, and rear steering mechanism are also connected. At station four, the front steering assembly is added, along with the brakes and battery. The fifth station adds whatever accessories are desired, completes all connections and readies assembly for the installation of the upright hoist unit. After this, at the sixth station, there is the final addition of the upright hoist assembly with front wheels and overhead guard. Now completed, the lift truck is driven from the assembly line for inspection, final spray painting, and final inspection prior to shipping. Parallel to this main assembly line, there is a quasi-assembly line for the production of the *Salisbury* turret truck. At present, due to the diversity in models, since approximately 25 variations are available, this assembly line is to a great extent a custom construction operation. The *Salisbury* turret truck handles 20,000 *lb* loads with its five horse motor, and is expected to be of great use to the railway industry.

Hyster and You

Within the last two years, Hyster in Danville has doubled its payroll, and, at the present time, is employing slightly less than 500 workers. This trend has rather an encouraging flavor for those of you who will soon be meeting the labor market, for it means that there will, in all probability, be a promising demand for engineers capable of meeting Hyster's requirements. When considering these "requirements," it is well to note that, at present, a large percentage of Hyster's engineering staff is comprised of University of Illinois graduates. It is a policy of the plant to do much of the recruiting for industrial talent from this University. Hyster's affinity for University of Illinois engineering students is particularly fortunate because of the fine working conditions which are present at the plant. There are the usual inducements, paid holidays, overtime premiums, a paid vacation schedule based upon length of employment, wage differentials for workers of second and third shifts, an annual bonus, and a pension plan, but the friendly spirit that prevails is also an invaluable asset. For example, one of the men remarked to me, "I've only been here a little over a year, but I'll bet that I already know 400 of the 500 men in this plant by name." This seems to be the rule rather than the exception. It spells cooperation. Reflecting this cooperative spirit is the employee organized credit union for saving and borrowing, and the mutual benefit association which compensates members for time lost through illness or accident which is not covered by workmen's compensation. The Hyster family also has its sports agenda, including bowling, basketball, and baseball.

Though predictions as to any future trend is risky, whether Rose Bowl or industry, present indications, as reflected in a discussion with members of the production planning staff, seem to indicate that the expansion of a growing Hyster Co. will accommodate the talents of a few new engineers in the near future. This may be of more importance to you due to the fact that Hyster has long followed the policy of picking *young* men for the organization. The cumulative effect of this information is best summed in this suggestion: If you are interested in obtaining information as to YOUR opportunity with Hyster Co., contact Vic Vandevoir, the very able personnel manager, who will be glad to discuss job opportunities with you.

The QN-20 can be equipped with a revolving Load-Grab. This particular model has a 12 ft. lift. (Courtesy of Hyster Co.)

Next Month *Central Foundry Division*, General Motors Corporation

German crowd, part of the 1,250,000 from East and West Berlin, sees a typical RCA television program.

"Freedom's window in the Iron Curtain"

You've read the story of last summer's TV demonstrations in Berlin. It attracted a million and a quarter Germans – including thousands who slipped through the Iron Curtain to see Western progress at work.

Behind this is another story: How RCA engineers and technicians broke all records in setting up these Berlin facilities. The project called for a TV station and studio, a lofty batwing antenna, and the installation of 110 television receivers at strategic points. Such a program would normally take several months to complete. It was installed and put to work by RCA in a record-breaking 85 hours!

Programs witnessed by Berliners included live talent shows, sports events, news commentaries, and dramatizations of the Marshall Plan. Observers pronounced reception fully up to American standards – another impressive demonstration of democracy's technical ingenuity and leadership.

* * *

See the latest wonders of radio, television, and electronics at RCA Exhibition Hall, 36 West 49th St., New York. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y.

Continue your education with pay – at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey. **Also many opportunities for Mechanical and Chemical Engineers and Physicists.**

RADIO CORPORATION of AMERICA

World Leader in Radio — First in Television

introducing . . .

by Tom Madden, m.e. '54, Henry Spies, ag.e. '52

JACK RITT

One of the outstanding members of the February graduating class is Jack Ritt. He will receive his degree in communications engineering in the department of electrical engineering.

A native of Racine, Wisconsin, Jack is a veteran of 22 months in the Navy. During his military career he attended electronics school and served as a transmitter attendant in Bermuda. A true dry land sailor, the most water he encountered was in a tropical hurricane while stationed there.

Jack entered the University of Illinois in September, 1948, soon after being discharged from the Navy. Since that time, he has been making himself known throughout the campus. A member of Delta Upsilon fraternity, he worked on the Campus Chest during his first year. His other activities include being a member and secretary of AIEE-IRE, chairman of the awards committee of Eta Kappa Nu, electrical engineering honorary, Tau Beta Pi, and last year he was vice president and this year president of Sigma Tau, engineering honorary. He also is song leader and house manager of his fraternity.

JACK RITT

His collegiate career has also included one semester at the University of Wisconsin, where he fulfilled the dream of most engineers and took no engineering courses.

When he has time for hobbies, he pursues his favorite, photography. He has been an amateur photographer for the last eight years.

In February, industry will gain an outstanding engineer. His campus associates are sure that he will exceed expectations.

BOB LENZINI

Many students here at Illinois are familiar with the fine defensive line work of Bob Lenzini '54 on Saturday afternoons in Memorial Stadium. Few of them, however, realize that Bob's real ambition for life's work is a career in civil engineering.

Bob, who lives in North Chicago, Illinois, graduated from Waukegan Township high school with the class of 1950. While attending Waukegan high, he studied a college preparatory course containing the courses needed for entry into the U. of I. college of engineering and at the same time participated actively in football and track. When asked why he chose engineering to study, Bob replied that he has always been interested in it and decided some years ago to take it up upon entering college.

BOB LENZINI

A sophomore in civil engineering, construction option, Bob finds that his schoolwork and football playing keep him well occupied most of the time. Bob is a member of the local chapter of

(continued on page 30)

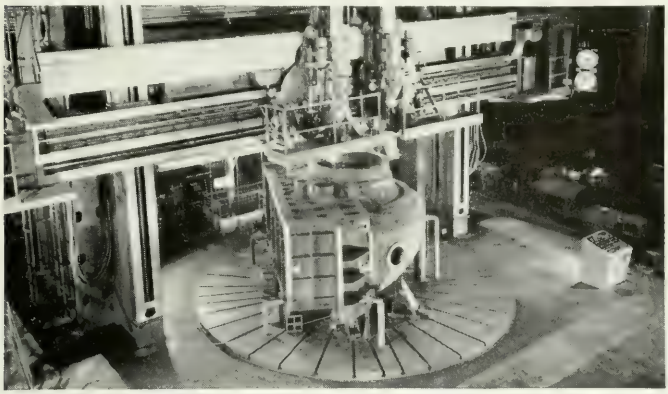
WHERE
TENSION CONTROL
AND LEATHER
make a good team
TENSION-CONTROLLING MOTOR BASE
FLAT LEATHER BELT
In the fielder's glove, a hand controls the tension that makes the leather take hold. In the Uni-Pull drive, a tension-controlling motor base and a modern leather belt team up in practically the same way. The base maintains belt tension . . . keeping leather's high pulley grip at work, effectively transmitting power.
American LEATHER BELTING Association
AL-51

Behind Every Success There's
PLANNING

H. V. FULLER

by H. V. FULLER, *Supt. Time Study and Planning Dept.*
General Machinery Division, ALLIS-CHALMERS MANUFACTURING COMPANY (*Graduate Training Course 1939*)

PLANNING is an important part of manufacturing machinery—and of building a career, too. This planning, however, must be based on information and experience. You don't always have all the facts about industry that you need at the time you leave engineering school and start planning your own future. At least, that's the way it was with me when I got my degree in Mechanical Engineering at University of Wisconsin in 1936.



New 30-ft. boring mill now operating in Allis-Chalmers' West Allis shops. It supplements older, slower 40 ft. mill, and greatly increases capacity on big, heavy work. Both mills are scheduled practically around the clock, seven days a week.

I took a job with a big manufacturer, but within a year the work I was doing ended, and my employers referred me to the Allis-Chalmers Graduate Training Course. I enrolled in 1937—and then my knowledge of industry really began to grow. There was the usual round of the plant—shops, offices, various departments—where I saw a wide range of work at first hand. I worked with steam turbines, pump testing, and on the electrical test floor. About half way through the two-year course I got really interested in the manufacturing side of the business. After four months of plant layout work I went to the Time Study and Planning Department, and finished out my course there in 1939. In 1945 I became Superintendent.

This Is the Starting Point

In this department we really start the manufacturing operation. We're given the engineering drawings and material specifications. And from this data we plan the sequence of manufacturing operations—determine the equipment and tooling required, and set up time standards for each operation.

You can get some idea of the volume of work from the fact that our West Allis Machinery Division shops ship an average of eight million pounds of finished machinery per month—representing a range of products from small V-belt sheaves to massive crushers, steam and hydraulic turbo-generating units, cement kilns, sewage pumps, motors, flour mills, and power transformers.

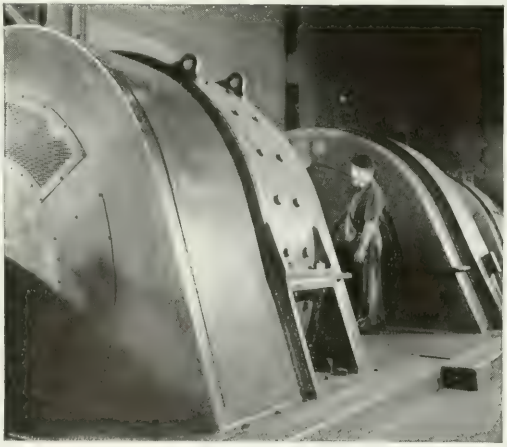
Look Before You Decide

As a Graduate Training Course engineer here you may become interested in manufacturing. There's a great need for trained engineers in this work. Or, you may find your interest lies in some other field—designing, research, sales, personnel, service and erection. In any case, the Graduate Training Course gives you a chance to look them all over, gain practical first-hand experience, plan your career on a sound basis of knowledge.

Do Your Own Planning

The course is flexible—you help plan it yourself and can change it as new interests or opportunities develop. There's no other spot in industry that offers such a wide range of experience—so many choices for a career.

If you want to get further details as to qualifications, salary and operation of the course, get in touch with any Allis-Chalmers district office. Probably the manager was a G T C himself. Or, write for literature.



One of the three 6000 kw 3-machine Allis-Chalmers motor-generator sets in large Eastern steel mill. These units provide direct current for motors driving 68-inch hot strip mill.

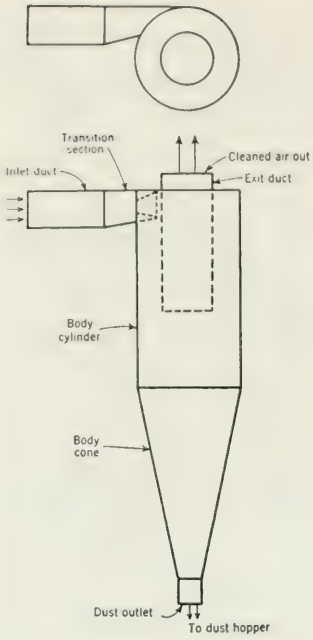
ALLIS-CHALMERS *Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin*

RESEARCH . . .

continued from page 31

waves. There are not enough of them. Aerosols obscure vision because they scatter light waves. The amount of light scattered depends upon the size and concentration of the particles as well as the index of refraction of the material. Most liquid aerosols scatter light most effectively when in the range of 0.3 to 0.6 microns in diameter. Large drops do not scatter light as effectively, but they absorb some to contribute to obscuration. The familiar blue haze of industrial areas is due to particles of 0.3 to 0.6 microns.

The mass of particles 0.5 microns in diameter necessary to obscure vision is about 500 milligrams per square meter. (Notice that concentration is given by area and not volume. This means that if one were looking through a tube one meter square, he could see only as far as the 500 milligrams of aerosol occupied the tube. If the volume were one cubic meter, the visibility would be one meter. If the volume were 10,000 cubic meters, visibility would be 10 kilometers.) An aerosol of this size at a concentration of one milligram per cubic meter allows 1,600 feet visibility. A fog of 200 milligrams per cubic meter with a particle size of 5 to 50 microns has a 500-foot visibility. While the small aerosol would have 1,600 particles per cubic centimeter, the fog would seldom have more than five.



The cyclone separator is the most widely used type of gas-cleaning equipment.

Because the mass and momentum of aerosol particles are very small, the particles tend to follow the streamline flow pattern of the gas around an obstacle. This limits water sprays as a means of removing aerosols from gases since the particles merely flow around the drops of water. A spray scrubber is useful only with particles of large size, and then only when the gas is exposed to the spray for 15 to 30 seconds. This same property limits the use of baffles for removing small aerosols. A combination of spray and baffles is often fairly effective, however.

If an aerosol is sufficiently concentrated, the particles will coagulate and lower the concentration. The rate of coagulation is approximately proportional to the square of the concentration and almost independent of the particle size. Aerosols existing in the atmosphere will not contain more than 100,000 particles per cubic centimeter.

Even though the vapor pressure of small droplets is higher than normal, small liquid aerosols quickly evaporate. Since only so much liquid can be contained by the gas as a vapor, larger drops are formed at the expense of the smaller ones. This explains why

(*continued on page 32*)

WASHINGTON'S LENCSHIRE HOUSE AIR CONDITIONED BY FRICK

The 126 apartments in this new 8-story building on Wisconsin Avenue are kept cool and comfortable by three Frick refrigerating machines. Evaporative condensers, placed on the roof, save 95% of the water otherwise required.

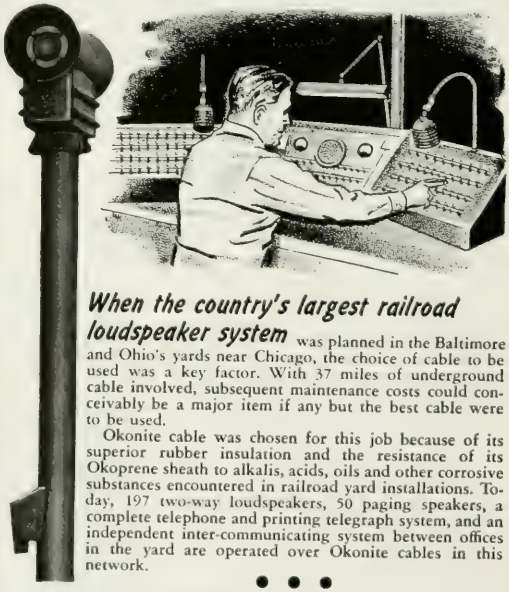
Installation by Harvey W. Hottel, Inc., Frick Distributors at Washington, D. C. Lencshire House was built and is owned by The Lenkin Construction Company.

Three NEW ECLIPSE Compressors in Service at Lencshire House

A Frick air conditioning unit (of 5 or 7½ hp. size) or a central system like that at Lencshire House, will increase profits in your business.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

DEPENDABLE REFRIGERATION SINCE 1853
FRICK & CO.
WAYNESBORO, PENNA. U.S.A.
Also Builders of Power Farming and Sawmill Machinery



When the country's largest railroad loudspeaker system was planned in the Baltimore and Ohio's yards near Chicago, the choice of cable to be used was a key factor. With 37 miles of underground cable involved, subsequent maintenance costs could conceivably be a major item if any but the best cable were to be used.

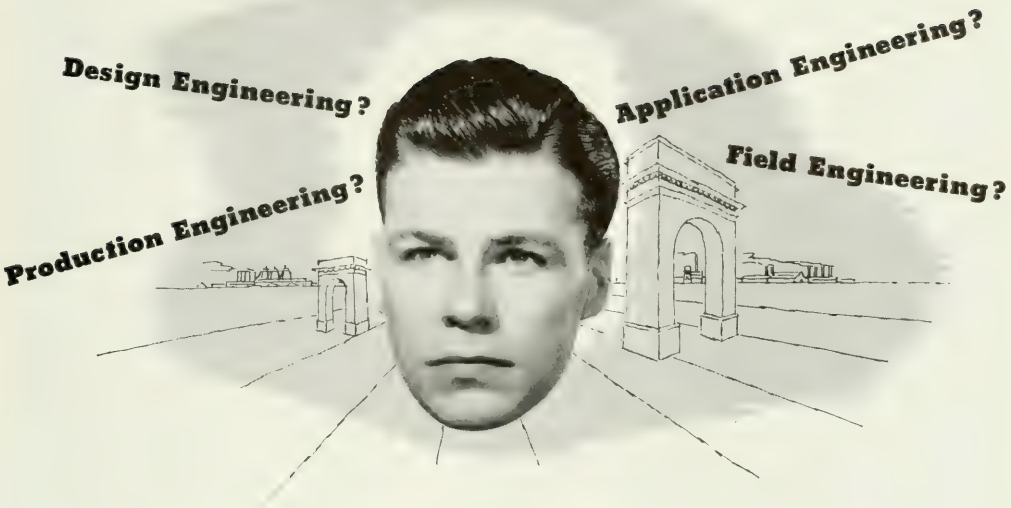
Okonite cable was chosen for this job because of its superior rubber insulation and the resistance of its Okoprene sheath to alkalis, acids, oils and other corrosive substances encountered in railroad yard installations. Today, 197 two-way loudspeakers, 50 paging speakers, a complete telephone and printing telegraph system, and an independent inter-communicating system between offices in the yard are operated over Okonite cables in this network.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE *insulated wires and cables*

9783



Which is *Your* choice for the future?

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GRILL CLOTH . . .

(continued from page 13)

the parabolic, the exponential, the hyperbolic, and the cylindrical. The last is more to be considered a transmission line and is used in only one instance; the acoustic labyrinth, a folded cylindrical horn which achieves the purpose of an infinite baffle phase inversion. The acoustic labyrinth may be a very compact unit, but its complex structural nature makes it a somewhat less inviting solution to the problem than would appear upon first consideration. Of the remaining types, the exponential and hyperbolic horns are most widely used. While an infinite horn will not radiate power below its cut-off frequency, the finite exponential and hyperbolic horns radiate almost undiminished power up to the cut-off, with the hyperbolic exhibiting a slight rising characteristic and, although power is attenuated, both will radiate below cut-off, whereas the finite conical and parabolic horns not only do not radiate below cut-off, but allow a decided attenuation of radiated power before cut-off is reached.

Folded exponential horns are widely used in theatres for efficiently radiating large amounts of low frequency power. In a size commensurate with ready placement amongst residential furniture is the Klipschhorn, a folded exponential corner horn of minimum dimensions. The design and construction of such a unit is exceedingly involved and represents a handsome investment of time and money, thus, unfortunately, placing this very desirable development out of general consideration.

Placement of the speakers and enclosures is quite important, particularly so, in the home. Most loudspeakers and baffling structures exhibit directional characteristics to a greater or less degree. Usually, the resultant acoustic power is concentrated along, or near, the axis of the speaker. Placement of the speaker assemblage near the middle of a wall results in several "dead" spots in the adacent corners of the room. If, however, the speaker is placed in a corner, not only is this undesirable condition ameliorated, but an even more attractive dividend accrues. Since the solid angle through which the source is required to radiate has been reduced from 2π to π, or π to $\pi/2$ steradians, the average power radiated has been increased by a factor of at least two, and possibly four. These effects hold rigorously for a simple point source only, but apply approximately for an open radiator such as a speaker in a flat baffle, and may be extended to other types upon occasion. This effect may be duplicated by mounting two, or four, or more single speakers close together on a large flat baffle. The effective mutual radiation impedance is increased to the point where the cones are effectively coupled to the air, whereupon, the speakers not only become more efficient, but more distortion-free. There is still another advantage to this system. Using several speakers of lower power dissipation capabilities, smaller speakers possessing a higher upper cut-off frequency are acceptable, providing a rather novel and inexpensive manner of attacking the problem.

This last mentioned method appears most attractive, and is certainly worthy of further investigation, because it, of all the various systems, does not involve a prohibitively expensive and complicated approach. Surely, there must be an easy way to do it!

INTRODUCING . . .

(continued from page 26)

Delta Tau Delta national social fraternity.

Upon graduation his plans are strictly in construction engineering, as he plans to end his football career here at Illinois. So here's "hats off" to Bob Lenzini—first string guard for the Fighting Illini, and a fine engineering student. Best of luck, Bob, in both of your chosen fields of endeavor.

Attention! February Graduates

Join Your Alumni Association Before Leaving

The Campus And Save

	Regular	Special	Savings
Annual	$ 4.00	$ 1.00	$ 3.00
Four Year	$16.00	$ 4.00	$12.00
*Life	$80.00	$70.00	$10.00

*Convenient payment plan available. All memberships include subscription to Alumni News

Send in your membership or call in person at our office

U. of I. ALUMNI ASSOCIATION

227 ILLINI UNION BUILDING

Dragonfly eye for a war plane— blown of optical glass

As any naturalist can tell you, the dragonfly has one of the best eyes there is for seeing.

His eye is a button, set well out from his head. It lets the dragonfly see in all directions without craning his neck.

Now war-plane pilots aloft have just such a convenient eye to see with—the glass bubble shown above. Set in the skin of a plane—and fitted with an optical system—it gives a clear, horizon-sweeping view.

This new kind of eye for war planes marks the *first time* in the history of glass-making that perfect optical glass has been mass-produced by blowing. And because the blowing is so accurate, the bubble needs a minimum of grinding and polishing to meet exact optical specifications.

Before such a bubble could be blown, Corning had first to develop ways of forming optical glass shapes directly from the molten glass. This was accomplished during World War II, when Corning devised a method of manufacturing lens blanks of perfect optical glass by machinery.

Today, shaping optical glass by blowing greatly extends the usefulness of optical glass for industry as well as the Armed forces.

Making optical glass more useful is just *one* way that Corning, in a full century of glass-making, has helped glass become one of today's most versatile engineering materials. Corning has developed more than 50,000 formulas for making glass, and they are being added to, day by day.

Throughout industry, *Corning means research in glass*—research that is constantly turning up new ways to make glass do countless jobs better than they've ever been done before.

So after you're out of college and are planning new products or improved processes, it will pay you to call on Corning before you reach the blueprint stage *Corning Glass Works, Corning, N. Y.*

CORNING
means research in glass

1851—100 YEARS OF MAKING GLASS BETTER AND MORE USEFUL—1951

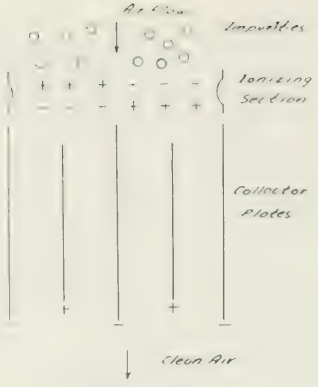
RESEARCH . . .

(continued from page 28)

ing droplets are seldom smaller than fifty microns.

The concentration at the ground of aerosols from stack gases depends solely upon the rate of discharge and not upon the concentration of the stack gases. However, the concentration and deposition of an aerosol increase with an increase in the stack height. The more turbulent the air, the less will be the concentration and deposition at the ground. Although much publicity has been given to the rate of collection of aerosols deposited as dust, such a measurement does not do any more than indicate the general cleanliness of the locality. It does not bear any relation to that part of the polution which affects visibility.

Aerosols which penetrate the respiratory passages will sometimes cause lung trouble. Although most types will merely color the tissues, silica and asbestos will cause pulmonary diseases. Silicosis, a menace to many coal miners, is caused by chemical action and is not a simple irritation problem. The disease often leads to tuberculosis. If the victim is exposed to the silica for a long period of time, his lungs may be virtually destroyed. In coal mining, the dust may be kept at a safe minimum by using wet-drilling and cutting methods; that is, by running water over the surface being worked on. The water is generally available in the mine.



Operation of Precipitator

Above drawing illustrates the principle of operation of an electrostatic precipitator. (Courtesy of the Iowa Transit).

If the particles to be removed from the gas are large enough, they may be removed by settling. By increasing the flow area so that the linear velocity of the gas is less than 10 feet per second, settling is easily accomplished. The efficiency of this method is increased by decreasing the turbulence of the gas. Often rods, screens, or curtains are suspended in the settling chamber for this purpose. The size of the settling prohibits this method for particles smaller than 43 microns in diameter.

The cyclone is the most widely used gas-cleaner. In a simple cyclone, the contaminated gas enters tangentially from the duct and passes through the annular section in a cork-screw motion. In the conical section, the direction of the gas flow is reversed, and the clean air leaves through the exit duct. The aerosol particles are thrown to the wall of the cleaner by centrifugal force and fall out the bottom. The efficiency is over 90 per cent for particles larger than 10 microns, but for particles less than three microns in diameter, cyclones are not efficient.

Aerosols can be electrostatically charged. If an aerosol is passed over one of a pair of electrodes, the particles will be attracted to the other. The electrostatic method of precipitation is widely used. Plants which have sulfuric acid mist in their waste gases very often use this method.

(continued on page 42)

First Choice for
DEMINERALIZED WATER

BARNSTEAD
DEMINERALIZERS

When manufacturing processes require *only* high-test mineral-free water, Barnstead Demineralizers are the best producers . . . 5c per 1000 gallons of demineralized water with a minimum of supervision and maintenance. Barnstead Demineralizers increase production, reduce rejects and insure better products control.

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CHROME-CLAD
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STEEL TAPE

Popular for heavy duty work on oil field, steel mill, or heavy construction jobs. Built with greater durability and unusually large easy-to-read figures. The Anchor features: patented Chrome Clad nonglare finish that won't chip, crack, peel or corrode. Finest genuine leather hand-stitched case. "Instantaneous" readings. Engineers who know specify *Lufkin* tapes.

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TAPES • RULES • PRECISION TOOLS
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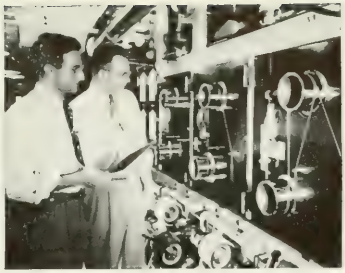
THE DU PONT DIGEST



F. E. SPELLMAN, JR., *B.S.M.E., M.M.E., Ohio State '51, and D. A. Smith, B.S.M.E., Purdue '40, discuss a change in feed wheel design of nylon spinning machine.*

M.E.'s AT DU PONT [3]

Plant engineering and production supervision offer interesting careers for science graduates

In the past two issues of the *Digest* you've read of the broad opportunities that are offered mechanical engineers in research and development work at Du Pont.

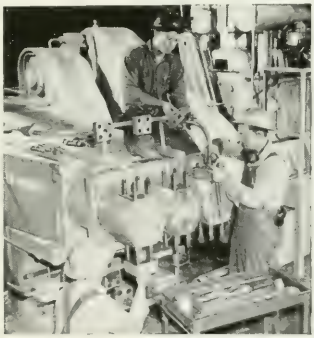
This month let's look at opportunities for men interested in any of the branches of plant engineering —such as maintenance, power, design and construction—or in production supervision.

Efficient maintenance is an important cost factor in the continuous processes of a modern chemical industry. The M.E. is called upon to diagnose troubles, work out corrective measures, and supervise repairs.

Frequently he increases production by developing preventive maintenance measures. So vital is this work that in one division of the Company, 500 men of all crafts, along with a routine maintenance group, spend almost all their time on it.

One example of the problems facing Du Pont engineers is the maintenance of pumps made to tolerances of 0.0001" and operating at pressures up to 6000 p.s.i.

In power work, also, problems requiring application of mechanical engineering principles arise. For instance, a metal required in one chemical process is melted at 800°F. by immersion heaters fired by butane, which is expensive. Conversion to fuel oil presented the problem of complete combustion in the immersion chamber. Du Pont M.E.'s redesigned the heaters so combustion could be complete and the hot gases recycled in water to use all the available heat.



OVERHAUL *on polythene area injection pump is six-hour job for three men. Work must be scheduled for minimum disruption of output.*

In design and construction of chemical plants, mechanical engineering again is of major importance because of the wide variety of plants built and intricacy of their equipment. Engineers collect basic data, design and select equipment. They also supervise many steps of construction until the plant is operating.

A FIREMAN *adjusts louvers for the proper combustion of pulverized coal. Blown into furnace through pipes, it burns at 2500°F.*

Production supervision attracts many mechanical engineers. Men who have the ability and interest usually move into it by one or two routes: they acquire background on all stages of a plant's operations by helping design the plant, or by operating on the job.

MAINTENANCE TEAM *making a speedy change of a methanol valve to minimize production loss.*

Sometimes students of mechanical engineering feel that in a chemical company they will be overshadowed by chemical personnel. This is not the case at Du Pont. Here, hundreds of administrators and supervisors, up to the rank of vice-president, started as M.E.'s.

.——.

Opportunities for men and women with many types of training are described in the 40-page brochure "The Du Pont Company and the College Graduate." For your free copy, address 2521 Nemours Bldg., Wilmington, Del.

DU PONT
REG U S PAT OFF

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Entertaining, Informative — Listen to "Cavalcade of America," Tuesday Nights, NBC Coast to Coast

A curious tourist recently visited some old ruins in New Mexico. While gazing at the dinosaur bones that were all over the place, he met an aged Indian who acted as a sort of a guide thereabouts.

"How old," he asked, addressing the Indian in his native tongue, "are those bones?"

"One million and three years old," promptly replied the Indian.

"That's cutting it pretty fine," remarked the tourist. "How can you be so definite?"

"A geologist told me that they were one million years old," replied the Indian, "and that was three years ago."

* * *

A young man whose father had been hanged was filling out a college application. After the usual hereditary questions, there was one asking the cause of the death of his parents. He thought awhile and finally put down this answer: "Mother died of pneumonia. Father was taking part in a public ceremony and the platform gave way."

* * *

Something that will pop up just before ST. PAT'S ball next March: "Is this dance formal, or can I wear my own clothes?" Answer: Take your choice, which means, wear your own.

NAVY PIER . . .

Continued from page 12

in its field and is a clearinghouse for information on the progress of most government, civil, and military engineering projects.

A I A

Louis Moro, president, student chapter American Institute of Architects, will present a movie on "Architecture in the Western United States" at the next meeting to be held early in December.

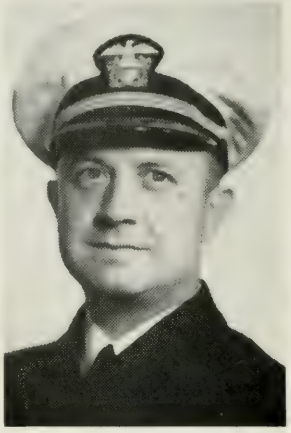
The group also is making plans to visit several new buildings now under construction in the Chicago area.

A S M E

The November meeting of the student branch American Society of Mechanical Engineers featured Mr. L. B. Cottrell of the American Steel Foundries who spoke on "Opportunities for Engineers in Railroading."

Mr. Cottrell outlined the various positions open to engineers in departments on American railroads and their advantages for the young graduate.

The ASME has featured other prominent speakers at past meetings relating to the student engineers future and plans to continue the series this fall and winter.



STEELE BRYAN SMITH

B.S. U.S. Navy Academy, 1923

Known not only in the general engineering drawing department where he was an instructor, but throughout the entire Pier, the infectious smile of this genial man did much to brighten even the cloudiest day.

Mr. Smith came to Navy Pier on its opening day in October, 1946, and was on the job daily until the second week of the fall, 1951 semester. At his home in Lake Zurich he passed away on October 27. His loyalty to the Pier is evidenced by the fact that he attended a football game between the Pier team and Camp McCoy only the day before his death.

As a Commander in the United States Navy, Smith held various positions, both at sea and on land. He saw service on a submarine in China waters and also was in charge of the Branch Hydrographic Office at Chicago before accepting a post as Executive Officer in charge of Tufts College Naval Training Unit. He held this post prior to his position at Navy Pier.

The following quotation from *Tufts Tracer*, a magazine of the Tufts Naval Training Unit issued at the time of his retirement, expresses the feelings of our students and faculty:

"No one called "attention" when the short, balding commander in blues walked through the door and out on the ramp of the right-hand balcony above the main floor of Cousen's gymnasium. But before he had descended the steps to the main floor, walking rapidly, every man in the assembly was standing and applauding. He waved, and the applause grew louder, swelling and beating the rafters. A lieutenant stood and motioned "enough," but the applause went on. After three full minutes the officers and guests sat down and reluctantly the applause subsided."

Such was the nature of the man we mourn.

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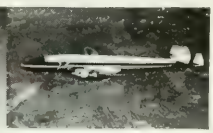
THE F-94 first all weather jet interceptor assigned to duty with America's aerial defense forces.



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SKIMMING . . .

(continued from page 14)

Despite the heavy loads handled by the crane, the main hoist motor is only 40 h.p. This power, transmitted through an extensive gear train, permits a maximum speed of four feet per minute when the main hoist is under full load handling the spillway gates.

deep-freezing with glycerine

Glycerine may one day be the means by which a champion race horse or prize bull may sire entire herds of offspring even after death.

Glycerine has been found to be an ideal medium for protecting and preserving live cells when they are quick-frozen. Unlike other substances, it has the unusual property of cradling the cells in the interstices of its crystal structure when suspensions of cells in glycerine are subjected to low temperatures. Cells can be kept immobile in that way almost indefinitely, and, in the case of sperm cells, still remain fertile and unharmed by the treatment of thawing. Other media, even if not toxic to the cells, crush or puncture them when the suspensions solidify.

The method has also been adapted to the preservation of red blood cells. In this case, whole blood is first diluted 10 to 20 per cent with glycerine and then frozen rapidly at —79 C. A recent method for removing absorbed glycerine from the cells after thawing has opened the way for possible large scale storage of supplies of red corpuscles which can be used for reconstituting whole blood from plasma.

Some cells are destroyed by the treatment, but in the case of blood cells, recoveries of 80 to 90 per cent have regularly been made. With both blood cells and sperm cells, it is the weaker ones that are lost, so that the process is, in addition to being a process of preservation of cells, a process of selectivity of the healthiest cells.

microscope for study of radioactive materials

Deadly radioactive materials, hidden behind a thick concrete wall, can now be safely studied and photographed under a microscope by atomic scientists.

The instrument is a special microscope for examining the structure of metals, combined with camera, periscopes and an illuminating system, in such an arrangement that light can get in and out through the thick walls of the test chamber, but dangerous radiations from the radioactive specimens are completely blocked.

Operated by remote control, the instrument permits atomic researchers to work in complete safety. Remotely controlled "mechanical hands" are used to place the specimens in position and to remove them after examination.

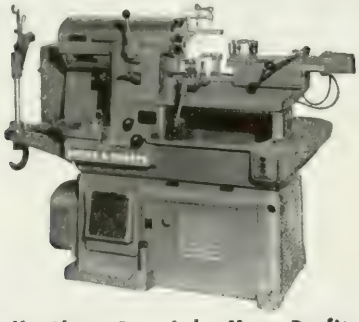
New cranes with sensitive controls designed to lift 250-ton loads have been installed at the McNary dam. (Courtesy of Westinghouse).

Light for illumination of the specimen comes from an arc lamp outside the thick-walled test chamber, and goes into the chamber through a lens system placed in a tubular hole through the wall. The light is reflected from the specimen, and comes out again through another series of lenses to form the magnified image.

Both lens systems are offset by means of mirrors, which change the light path from horizontal to vertical, and then

(continued on page 44)

NEW BROWN & SHARPE HAND SCREW MACHINES



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A "North Country" trapper...like Cast Iron Pipe...has STAMINA*!

Trekking long distances in the frozen North, on a trapline or behind a dogsled, demands stamina! And, just as surely, pipe *must* have stamina to serve for a century or more as cast iron water and gas mains are doing in more than 30 cities in the United States and Canada. In the generations since these gallant old mains were installed, horse-drawn vehicles have given way to multi-ton trucks and buses. Under the streets crowded utility services have been constructed. Yet cast iron pipe has withstood the resultant traffic-shock and beam-stresses because of its shock-strength, beam-strength and crushing-strength. *No pipe, deficient in any of these strength-factors of long life, should ever be laid in paved streets of cities, towns and villages.*

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* In a 340-mile midwinter race against death to bring serum to Nome, Alaska, a dog-team and driver covered more than 90 miles in a single day—a feat still remembered after 25 years.

Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3.

BILGE . . .

(continued from page 18)

University airport where a few of the school's antiquated B-36's took the dancers to the Congo. Everyone seemed to enjoy the dance, especially St. Pat. He has now decided to change his permanent residence from the Boulevard to the African jungle.

APRIL

After the departure of St. Pat, Engineering council proposed that the Boulevard be completely covered over. This proposal was quickly shouted down by the residents of Champaign-Urbana. They refused to be deprived of the clear, sparkling little stream which lends so much atmosphere to the Twin Cities. Said Champaign's mayor, "The Boulevard is like a breath of fresh air to me."

MAY

ASCE has volunteered to build an addition to Memorial Stadium during the summer. This addition will raise the seating capacity of the stadium to 101,369. Since everyone is well aware of the penniless condition of our Athletic Association, ASCE generously volunteered to bear the cost of this addition.

SEPTEMBER

Students returning after summer vacation were surprised by a new addition to the engineering campus, the Gar Fritts Memorial Tunnel. This tunnel runs under Green street between Civil Engineering building and the Illini Union. The tunnel was named for a former editor of The Daily Illini who valiantly fought for the safety of engineering students crossing Green street.

OCTOBER

Highlight of the fall semester was the dedication of the new 41-story physics building. Sparkling white, the building will be a campus landmark for years to come. One special rule was made concerning the building. No examinations may be given above the second floor level. Too many freshmen and sophomores had been jumping out of 30-story windows after taking physics hour exams.

NOVEMBER

The engineering college announced a radically new program this month. Starting next semester, all classes except laboratories will be given on television. This is practical now, since almost every study room on campus has at least one T-V set. Hour exams and finals also will be given on television, with students being put on their honor not to use textbooks or compare notes during exams.

DECEMBER

The U. of I. has made a welcome Christmas gift to the engineering student body. It has abolished all slide rules. To replace the slipstick, the University presented every engineer with a handy, pocket electronic calculator. These calculators were an instant success. In fact, they are working so well that there is a serious discussion of abolishing engineers as well.

And so we leave, with fond farewells . . . 1984.

An NROTC student was being put through the paces by an old sea captain. "What would you do if a sudden storm sprang up on the starboard?"

"Throw out the anchor, sir."

"What would you do if another storm sprang up aft?"

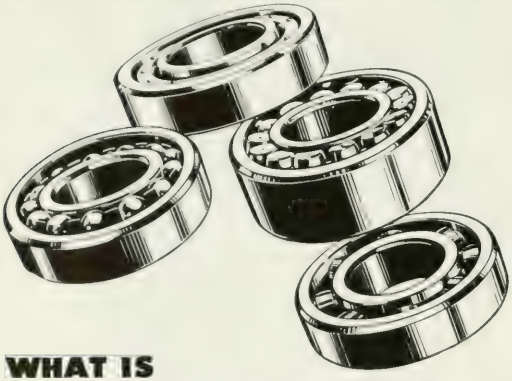
"Throw out another anchor, sir."

"And if another terrific storm sprang up forward, what would you do?"

"Throw out another anchor."

"Wait," said the Captain, "where are you getting all your anchors from?"

"From the same place you're getting your storms from, sir."



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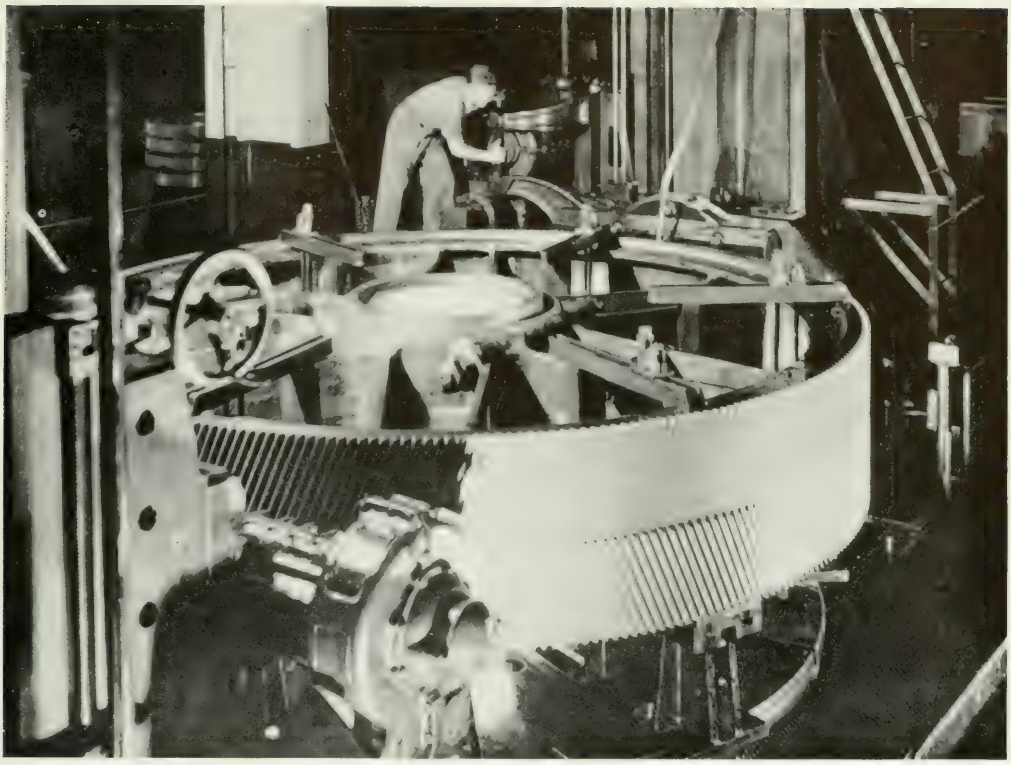

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Yes, there's more to "oil" than just oil. Standard Oil research, which looks to America's engineering colleges for new blood, is constantly facing and solving problems so as to increase efficiency and pack more hours and days into each year of machine operation—at a time when even minutes count.

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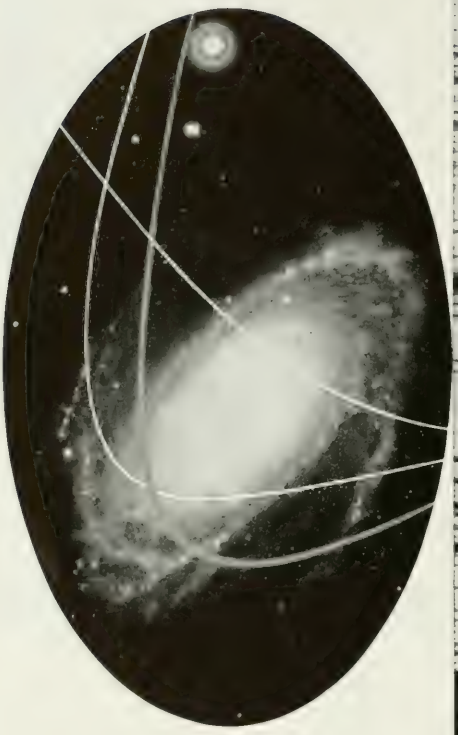
STANDARD



to be always beyond the frontier

Modern industrial research must constantly explore far beyond outposts of the known. For through this tireless reaching past existing scientific frontiers, the impossible of today becomes the reality of tomorrow.

The Howard Hughes Fellowships in Science and Engineering were established at the California Institute of Technology to encourage such creative industrial research and development. Any American citizen is eligible for a Fellowship who qualifies for graduate standing at the Institute for study toward the degree of Doctor of Philosophy with a major in physics or engineering.

Each Fellowship covers a twelve-month period. A portion of it is spent in advanced work in the Research and Development Laboratories of Hughes Aircraft Company. A Fellowship award provides a money gift, salary, and tuition and research expenses.

Dr. Clark Millikan (left) of the California Institute of Technology welcomes to the campus Hughes Fellowship recipients Art Bryson from Illinois and Warren Mathews from New Jersey.

Hughes Fellows Warren Mathews and Art Bryson are shown (left to right) with Dr. Robert R. Bennett and Dr. Allen E. Puckett examining the results of some random noise studies made with use of electronic analog computer in Hughes Research and Development Laboratories.

HUGHES

AIRCRAFT COMPANY

Culver City
California

How to apply for a Fellowship:

Write Howard Hughes Fellowship Committee, Hughes Aircraft Company, Culver City, California, for application blank and brochure giving further details. Completed applications must be received by the Committee not later than January 7, 1952.

PHOSPHORUS . . .

(Continued from page 20)

It is almost impossible to calculate the rate of phosphorus absorption by a chemical analysis, but the tracer method proves to be simple and accurate. The tracer method can be performed by merely adding a radioactive fertilizer to the soil around the plant and taking daily readings from a Geiger-Mueller Counter apparatus placed near the plant. The results from these experiments reveal that corn, cotton, soybean, alfalfa, and ladina clover absorbed a high percentage of their phosphorus from fertilizer in the early growth. Potatoes, on the other hand, were found to absorb phosphorus steadily throughout their growing season. The difference in speed with which plants absorb phosphorus was found to be amazing. It took 40 hours for a grapevine to absorb some radioactive phosphorus placed at its roots and transfer the phosphorus to its leaves, while the same process was performed by a tomato plant in a matter of minutes.

Making use of the radioactive tracer and the guto-radiograph, it is possible to make a picture of the exact movements of phosphorus throughout a plant. The picture can be formed by merely placing the plant tissue, which contains radiophosphorus, against a special film for a few hours. The radiation produces an image of its position. Vincent Sauchelli, chairman of industry's Phosphate Research Committee, has stated that plant guto-radiographs "could be used by those who are developing better methods of tissue-testing for determining the nutrient deficiencies." Experiments with guto-radiographs revealed that phosphorus salts in trees are transported in the bark and not through the wood as sometimes believed. During the last growing period of wheat the radioactive phosphorus can be traced out of the stem and leaves and into the head of the plant.

The phosphorus tracer technique has proved itself useful in the study of certain plant fungi. A few stalks of wheat were inoculated with the common leaf rust. By taking guto-radiographs of the movement of radiophosphorus, it was possible to show that the phosphorus went directly to the infested areas. The concentration in these spots may be the cause of the damage done by leaf rust to plants. A similar example was shown when guto-radiographs were taken of a tree that was infected with a root fungus. The phosphorus was concentrated in the damaged roots and was not transferred to the young growing tips.

The use of radioactive phosphorus as a tracer in animal metabolism has so far been very limited, but as research progresses the number of possible applications for the tracer method will be indefinite. The first extensive metabolism research with tracers had been performed at the University of Saskatchawan, Canada. The University has started a group of tracer experiments to study the relationship between the phosphorus fed the hen and that in the egg. These experiments are started by merely feeding the chicken a measured amount of radiophosphorus mixed in the feed. With a Geiger-Mueller Counter it is then possible to find the amount of phosphorus used in the production of eggs and the development of bones and muscle. Experiments have been started to study the movement and metabolism of phosphorus from the plant through the animal, but at this time no results are available.

Many noted statesmen have said that hunger has caused more wars and unhappiness than any other one thing in the world. They have stated that if the problem of world-wide hunger could be brought to a minimum, it might be the end of world wars. The radioactive tracer is not expected to solve all the causes of hunger, but it is a good step in the right direction.

Social tact is making your guests feel at home, even though you wish they were.

RESEARCH . . .

(Continued from page 32)

Two types of filters are in use for the removal of aerosols. The deep bed, or fiber filter consists of multiple layers of glass, wool, asbestos, or cellulose fibers. The fibers may be used in any combination or separately. The diameter of the fiber determines the efficiency of each layer. The efficiency of the whole filter is an exponential function of the number of layers. Cloth, or fabric filters can be worn from cotton, wool, asbestos, glass, or a synthetic fiber such as nylon or orlon. Steel wool has even been considered for high temperatures. Unless they are cleaned frequently, the filter will hinder the flow of the gas. When the filter is working properly, the efficiency is 60 to 80 per cent.

As stated above, spray scrubbers are ineffective for removing most aerosols. By combining the spray and the cyclone in one cleaner, however, an efficiency of 97 per cent or better may be achieved for particles larger than one micron.

The newest development in the removal of fine aerosols is that of coagulation by high-frequency sound waves. Waves with a frequency between 1,000 and 10,000 cycles per second with an intensity upwards of 150 decibels are used. The coagulated particles are then removed from the gas stream by one of the other gas-cleaning methods. In removing sulfuric acid mist, the large particles are collected in a cyclone. Efficiencies of this method are in the range of 90 per cent.

There are other methods for removing aerosols, but those mentioned are the most popular. While the country may be the only place where pure air is available at the present, the day is coming when man will be able to clean up the mess he has made of the air we breath.

People who have an hour to spare usually spend it with someone who hasn't.

American Society of Civil Engineers

(ASCE)

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Small Change adds up to Millions

Perhaps you've noticed that lamp bases, traditionally made of brass, now are being made of aluminum. There's a story behind this change and it tells a lot about the kind of jobs going on at Alcoa.

It started several years ago when engineers of two leading lamp manufacturers agreed with our suggestion that bases of aluminum would cost less. "But will they be as good . . . will we have to revise our methods?" they asked.

The potential savings, a few mills per lamp times the 830 million sold each year, made finding the answers worth-while. Together we started two long-range research projects. One, to test aluminum alloys in the weather, fumes and years of standing idle that lamps must endure. The other, to find the alloy that would take five progressive draws, then thread rolling and finally, the high temperature of the red-hot glass that is poured in the base.

We tested samples, changed alloys, varied tempers, rolled different thicknesses. Lamp manufacturers tried each, until one met all requirements. Our development men worked long hours to get the right solder and flux to join the side wire to the base. Adapted them to the high-speed, lamp-making machines.

All this time, the manufacturers had aluminum bases installed in seacoast and industrial atmospheres. Our laboratories ran other tests on lit and unlit lamps under corrosive conditions. After 1½ years the reports came in: Aluminum bases measured up in every respect: conductivity, corrosion resistance, ease of installation and removal.

This is typical of the research and development jobs now underway at Alcoa. And others are waiting for the men with the skill and imagination to tackle them. ALUMINUM COMPANY OF AMERICA, 1825 Gulf Building, Pittsburgh 19, Pennsylvania.

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LEON R. LUDWIG

•

Leon R. Ludwig, 47, director of engineering and research for the Westinghouse Electric Corporation's Atomic Power Division, and former manager of the Company's Buffalo plant, died at his Pittsburgh home November 14 after a six-weeks' illness.

Joining Westinghouse shortly after graduation from the University of Illinois in 1925 with a B.S. in electrical engineering, Mr. Ludwig attended the Westinghouse engineering school and the Company's design school. He was then selected to work in the office of R. E. Hellmund, chief electrical engineer. In 1929 he was awarded the first Lamme Memorial Scholarship, which allowed him to spend a year at the University of Berlin, Germany, making a special study of conduction of electricity in gases, vacuum tubes, and mercury rectifiers.

Returning to Pittsburgh in 1930, he was named section engineer in charge of mercury-arc rectifiers, and later aided in the development of the ignitron. In 1935 he was made manager of the protective devices engineering department, and made several important contributions to the compressed-air circuit breaker then under development. During World War II he played a prominent role both at Westinghouse and in the industry at large in the development of shock-absorbing circuit breakers for the Navy.

During 1943 Mr. Ludwig averaged one trip every three weeks to Berkeley, California, where he assisted in the Westinghouse project of developing assential switchgear apparatus for the work of Dr. Lawrence of the University of California, work that led to the development of the atomic bomb.

Late in 1943 he assumed full charge of the Motor Division, and at war's end supervised the Division's move from East Pittsburgh to Buffalo, N. Y. He returned to Pittsburgh again in the fall of 1950 on special assignment, and was named director of engineering and research for the Atomic Power Division in October, 1951.

SKIMMING . . .

(Continued from page 36)

back to horizontal again. Radioactive radiations from inside the test cell are not reflected and cannot get around the offset.

In using the microscope, which extends into the test chamber, the specimen is put into place on the microscope stage. Looking through a single eyepiece, the operator employs the remote controls to get the specimen adjusted and properly focused. Then the visual eyepiece is exchanged for a photographic one, and the camera is swung into position to make the photograph.

At the lowest power, the instrument shows the specimen in its actual size, while the highest power lens gives a magnification of 1,000 diameters. These different powers are achieved through the use of several objective lenses for the microscope, which are mounted on a revolving turrent and can be swung into place by remote control.

Polarized light, which is invaluable in the study of metals, may also be used. This is achieved through the use of a light-polarizing slide inserted in the path of light from the illuminator.

anchors for planes

Liaison planes often find it necessary to land in confined areas. To facilitate such operations, the Air Materiel Command has developed a a rocket anchor to shorten landing distances. The anchor consists of a 28-*in* steel tube mounted in the tail assembly and filled with rocket propellent. Attached to the tube is a 200-*ft* stainless steel ribbon wound on a hydraulic brake. Just before touching the ground, the pilot presses a button which fires the anchor and drives it 18 *in* into the ground at approximately a 45-degree angle. As the stainless steel ribbon unwinds, the brake slows the plane to a smooth, easy stop which shortens the normal landing distance of the plane considerably.

brooklyn bridge renovated

The Brooklyn bridge is being renovated to serve today's traffic needs. It has been necessary to make the construction work very exacting, since the new part of the structure had to match the 19th century architecture of the rest of the bridge.

The 68-year-old East river bridge formerly carried two streetcars and two elevated tracks and about 3,000 vehicles a day. But the subway has replaced the elevated, buses have replaced trolleys, and motor traffic of all kinds has increased rapidly.

Objectives of the reconstruction was to provide two three-lane roadways, which would carry nothing but vehicles, at a rate of 6,000 a day. To do this an existing intermediate stiffening truss had to be eliminated. The cheapest method would have been to put in a completely new, deep outer truss, fabricated of rolled sections.

But New York's Fine Arts commission said such a change would be inconsistent with the bridge's architecture and would destroy its 19th century charm. Since the Fine Arts commission, which passes on modifications of the city's historical landmarks, would not allow the change, it was necessary to revive the truss by using the same structural elements originally used; small latticed and boxed members for compression and eye-bars for tension.

Work on the bridge was begun in 1950 and the south roadway is now complete. All six lanes are expected to be completed by next spring.

Aptitude Test?

If you're one of those students who has aspirations of becoming a great creative engineer—better start boning up on your geometry.

One of the nation's top-ranking inventors says that the ability to solve geometry problems is the best intelligence tests for creative engineering ability.

Dr. Ernst F. W. Alexanderson, radio and television pioneer, who was recently awarded his 320th patent for inventions made during his 49 years with General Electric, explained that algebra can be figured by routine rule, while the solution of geometry problems requires the use of imagination.

"If an intelligence test for engineering should be adopted, I would say that the ability to solve geometry problems should be the first consideration," he said.

* * *

The patient clerk took every pair of shoes off the shelf for his woman customer. The floor was strewn with shoes of all styles and colors. Finally he said, "Lady, that is our stock."

"Is that all you have in the store?" she said, disappointment evident in her voice.

"Yes, lady, excepting the pair I've got on."

* * *

Insurance doctor: Ever had any accidents?

Cowboy: Naw.

Doctor: What's that bandage on your hand?

Cowboy: Rattle-snake bite.

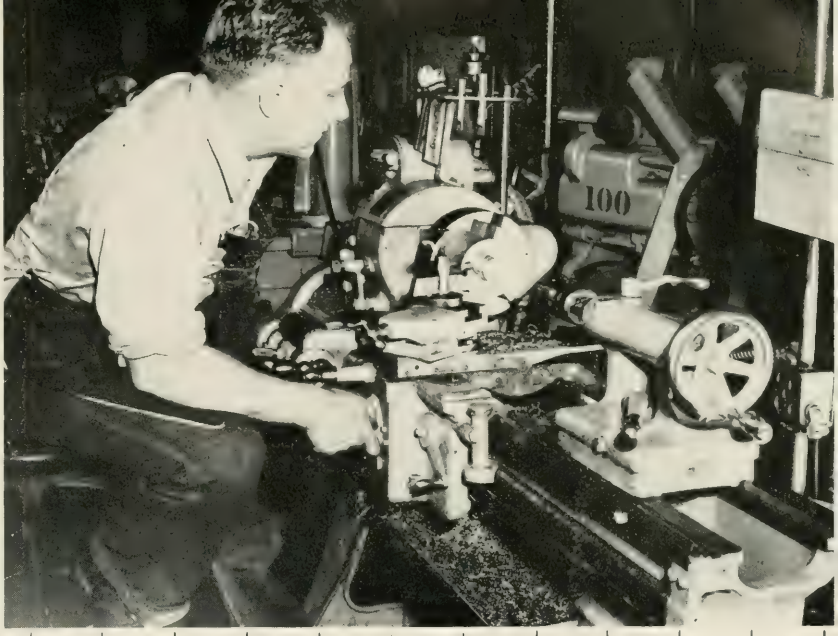
Doctor: Don't you call that an accident?

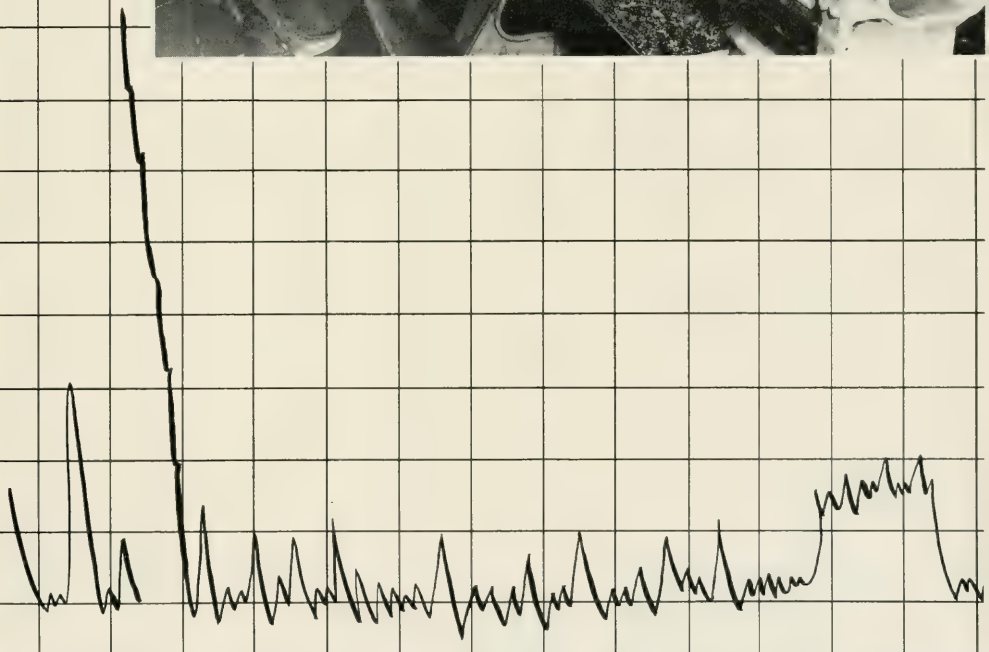
Cowboy: Naw, that dang thing did it on purpose.

* * *

When you argue with a fool—be sure that he isn't similarly engaged.

25¢





the **illinois technograph**

ember
t. m. a.

january, 1952

Another page for **YOUR BEARING NOTEBOOK**

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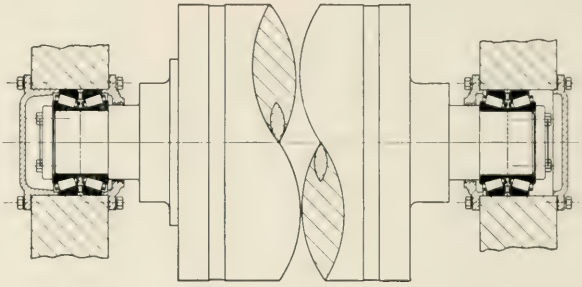
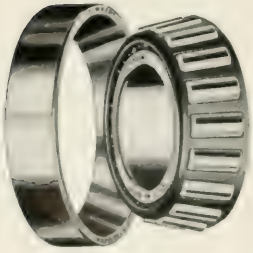
How to mount press cylinders

Type TNA Timken bearings are used at each end of this press cylinder. The bearing at the left is fixed by clamping the double cup while the other bearing is permitted to float. The bearing cones are clamped on the shaft by means of an end plate and cap screws which are locked by wiring the heads. The double cup for both bearings has a groove and oil holes through which the lubricant is supplied.





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NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ⓪ AND THRUST —⓪— LOADS OR ANY COMBINATION ✳

Let's face it, Pal . . .

Perhaps this editorial should be entitled, "The Trials and Tribulations of College Athletes" or, "How to be a Professional Amateur in One Easy Lesson." However, not wishing to shock anyone, I've used a more unobtrusive title.

How can one become a professional amateur in one easy lesson? Easy! Just enroll in a sports-minded university. First, however, you must be an athlete and a GOOD one, at that. The rest is easy.

Does the University hand out large sums of money to prospective athletes to encourage them to enroll at Illinois? No—nothing as crude as that. They may give out athletic scholarships which cover tuition expenses, and then there are always constructive, worth-while jobs for needy athletes, like keeping the snow off the basketball floor.

Also, there are always loyal alumni. They're so happy to see GOOD athletes enroll at Illinois that they just can't help but aid them financially. They might help them out with some of their other expenses, and with the left-over change, the athletes may even have enough to buy a car.

Why does this situation exist? Everyone wants to have a team that they can be proud of—a team they can brag about. In fact, some people are so interested in having a good team, they're literally willing to pay for one. If they didn't resort to such measures, they'd lose their prize athletes to other schools where more lucrative gains were to be had. Consequently, the team would fold, certain individuals would lose their jobs, and all-in-all, things wouldn't have such a "rosy" future.

Let's face it, pal, if you want to watch an amateur team in action, you'd better go back to high school.—H.P.K.

how hot?

Oxygen bubbled through molten stainless steel scrap, removes impurities and reclaims badly needed nickel and chromium.

how cold?

"DRY ICE" (Solid CO_2 gas) refrigerates your blood donation to preserve its life-giving effectiveness during its flight overseas. This same gas also sparkles soft drinks, and helps keep food fresh.

AN AIR REDUCTION PRODUCT

at the frontiers of progress you'll find

It's a long step from reclaiming highly critical nickel and chromium to the refrigeration of whole blood — yet Air Reduction takes it in stride.

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In fact, wherever progress is racing ahead, not inching to new frontiers, you'll find an *Air Reduction Product*.

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the illinois technograph

volume 67 number 4

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our cover

Featured in this month's issue is the mechanical engineering department. One of the more common operations on the lathe is being performed in the machine tool laboratory.

our frontispiece

An insulation development engineer at the Westinghouse Electric Corporation's East Pittsburgh, Pa., plant uses a medical cystoscope to examine the insulation deep within the coils of a generator. A series of visual and electrical tests has been devised that determines the condition of the insulation on large, rotating electrical machinery. (Courtesy of Westinghouse)

the technograph features the . . .

Mechanical Engineering Department

by Tom E. Madden, m.e. '54

Few students today realize that the mechanical engineering department here at the University of Illinois had its beginning in a mule stable. Established in 1867 as a school of mechanical science and art in the polytechnic department, it is the oldest department in the college of engineering. Soon after its establishment, Mr. S. W. Robinson was appointed the first professor of mechanical engineering and the Board of Trustees granted $2,000 for the equipping of a small wooden building, which had been used as a mule stable, with the essential tools to teach the new curriculum.

Professor Robinson and his small group of students worked diligently in their crowded classroom. One of the fruits of their labor, a ten horsepower steam engine, is today on display as a museum piece in the mechanical engineering laboratory.

In 1871, the legislature appropriated funds for the construction of a two-story structure to be used as the M. E. building and drill hall. Later, University Hall was built and the M. E. department carried on all of its work there with the exception of shop practice, which was still done in the previously constructed dual purpose building. More than one-half of all male students enrolling in the rapidly growing University entered the college of engineering. As a result, the need for increased engineering facilities became acute and led to the construction of Engineering Hall in 1893. The M. E. department was given a large portion of the third floor of this building in which to maintain offices and hold classes. About the same time, a power laboratory was started on the ground floor of the present Harker Hall.

Expansion of the M. E. department has continued to be rapid right up to the present day. In the interim between 1895 and 1944, several small buildings and portions of buildings were built or equipped for different phases of the department's activities. Among these were the machine tool laboratory, the mechanical engineering laboratory, and the second floor of the transportation building. However, it was not until the completion of the new, ultra-modern building in 1949 that the dream of the department came true, and all major functions were united under one roof.

Today the M. E. department is the largest in the engineering college with an undergraduate enrollment of about 550 students and a faculty staff of nearly 100. In addition 26 men are currently working on their doctorates and 24 on their masters degrees. The department has indeed advanced a long way since the first classes were conducted in a converted mule stable.

TOM MADDEN

Tom, a sophomore in mechanical engineering, hails from Freeport, Ill. Since he is in the NROTC program, his plans for the future have been conveniently arranged for him.

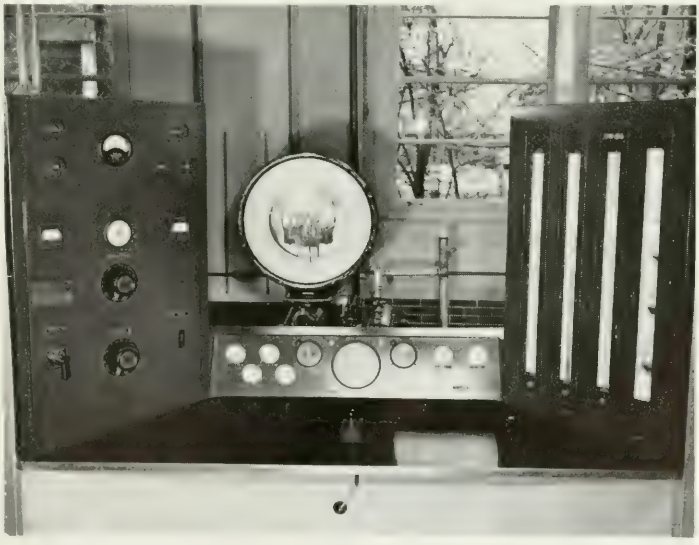
At Illinois, Tom is a member of Lambda Chi Alpha social fraternity and serves on the high school relations committee at the University YMCA.

His hobbies include working on radio sets and photography.

Aside from physical expansion, the M. E. department has greatly enlarged and improved its curriculum. The option system has been inaugurated so as to provide the student with a convenient means of placing emphasis on any one of the following phases: aeronautical, air conditioning and refrigeration, machine design, petroleum production, power, research, production, railway motive power, and general (which permits the student to select about 24 hours of either technical work cutting across the special options, or of non-technical electives in other colleges). Plans are now nearly completed for an additional option, which is, in effect, a new curriculum within the M. E. department. This new course of study leads to a degree in industrial engineering, a phase of engineering which is becoming more and more important every day.

A primary objective of the M. E. department is to provide the student with the best general education possible and at the same time not sacrifice any of the essential technical and scientific courses needed for graduation. This policy is in line with the views of men who are today far advanced in the engineering profession, and who have learned by experience that this type of education and character development

(continued on page 26)



A view of a test rack in the extensively equipped Internal Combustion Engine laboratory.

inside industry with Al Vejar . . .

Central

General Motors Corporation

"General Motors" is almost a household word, but it is more than the brand name of a series of products, for it represents the cumulative assets and influences of a great industry. This industrial empire encompasses more than 100 manufacturing plants in 5 cities of the United States and is supplemented by assembly and manufacturing plants in 18 other countries.

The complexities of control imposed by such scope necessitate a functional subdivision and coordination of the whole which is comprised of individual productive elements. The organizational network of operating units, or divisions, has been so contrived that each division is headed by a general manager who is responsible for the operational efficiency of his individual organization. Each division designs and distributes its own products, hires and trains its own employees, handles its own personnel problems, develops and maintains its own executive staff and operating organization, purchases its own materials and equipment on a competitive basis, and develops the manufacturing processes and methods best adapted to its particular needs and resources.

This criteria becomes more involved when we consider that some of the divisions are composed of a number of plants located in different parts of the country, which must be coordinated by a group executive.

Though such a progression of control seems complex, this organizational setup has the advantage of allowing operation without the limitations imposed upon small business, and yet it eliminates many of the drawbacks of centralized big business. A great flexibility is inspired by the limitation of size. The financial resources and staff facilities of the entire corporation integrally supporting the individual division provide the solid base upon which high production may be built.

Products and influences of this organization are too numerous to categorize, but one point should be emphasized. The stimulative influence such an organization can have upon the development of ability and initiative, through associations, training, experience, and advancement is, undeniably, invaluable.

Central Foundry Division An Evolution

The seed which has grown to such stalwart proportions was first planted in 1917, when the Saginaw Malleable Iron Corporation was founded in Saginaw, Michigan. This company, which manufactured castings principally for the automotive field, was purchased by General Motors Corporation in 1919 and became the Saginaw Malleable Iron Division of General Motors, operating as an individual unit.

Foundry Division

General Motors Corporation

During the Second World War, shortages and vastly increased industrial demands caused the government to build a malleable foundry to be operated by Saginaw Malleable Iron division of General Motors Corporation. The location, Danville, Illinois, was decided upon because of a series of factors including the availability of manpower, rail accessability, housing, proximity to dependent plants, and the need for decentralization of industry. Saginaw Malleable Iron Division operated this plant in the manufacture of malleable castings for army trucks and tanks from its inception in 1944 until the cessation of hostilities and the termination of war contracts caused discontinuance of production. General Motors then purchased this plant from the government and reorganized the Saginaw Malleable Iron Division into Central Foundry Division of General Motors. The Danville plant was reactivated and the Central Foundry triumvirate was completed with the construction of a plant in Defiance, Ohio.

When reopened in 1947, the Danville plant was solely equipped to produce grey iron castings. Most of the malleable iron equipment used during the war was not adaptable to peacetime industrial uses, as the wartime castings previously made were of such large size and irregular type that the equipment remaining was uneconomical and impractical for peacetime production. This lack of proper equipment necessitated the complete refitting of the plant. Automatic molding and conveying machines were installed throughout. In 1948, additional plant expansion was carried out when a malleable iron foundry equal in size to the grey iron plant was added. This growth has continued with the addition of floorspace and equipment to the grey iron plant.

In reflecting, it is evident that there has been a remarkable development within this plant. In the last five years, its employment has enlarged from the original 250 to over 2,000. This total will again increase when the next step of expansion is completed, for the capacity of the malleable iron plant is to be doubled by the fall of this year.

The expansion of Central Foundry cannot be solely attributed to General Motors Corporation contracts. All castings necessary to General Motors, as a whole, are bid upon by the plants both independent of GM control and within the framework of the corporation. Likewise, the foundries of General Motors bid upon contracts outside the GM sphere. As an example, the Danville Central Foundry Division is now producing parts for Ford, Packard, and Bendix.

Defense contracts are on the upswing and the CFD is currently producing parts for a new *hydromatic* transmission for army trucks, designed to give a high rate of acceleration, and a new test rocket casing for the Army Ordnance. Now, let's take a look at the plant as it is operating today.

Production—Plowshares and Swords

Central Foundry of Danville ranks high on the list of high-production foundries, and is generally acknowledged to be one of the cleanest, best equipped, and most efficient foundries in the world.

Integrally contained in the foundry building are a cafeteria, medical department, the executive and personnel offices, a plant and processes engineering department, and the very necessary sand and iron testing laboratories. All opera-

(continued on page 22)

A pattern maintenance man repairs and inspects an exhaust manifold pattern. (Courtesy of GM).

1952 Engineering Open House

by Bob Schrader, ch.e. '54 and John Schultz, cer.e. '52

Editor's Note: This is the first of a series of three articles designed to acquaint you with the biennial Engineering Open House. This issue we'll deal with past engineering open houses and in particular, the 1950 Open House.)

Already this year, while thoughts of Christmas past and finals yet to be are filling the heads of most students, engineering campus is humming with preparations for the 1952 Open House. During Open House, the engineering college and its associated branches throw open their doors to the general public for a weekend, showing them what is being accomplished in engineering at the U. of I. The Engineering Open House is not something new to the Illini campus, but instead is the result of a great tradition dating back almost to the turn of the century.

The Open House idea first started on the Illinois campus in 1906, when the physics department held an exhibit. This exhibit stressed "light, wireless telegraphy, and other electrical phenomena." Then in 1907, a drive started in the colleges to raise money for a memorial to Robert Fulton. In order to raise money for this memorial, the EE department put on a show very similar to the physics Open House of the year before.

The idea for an EE exhibit caught on, and these exhibits continued on up into the thirties. The EE shows were big productions, with much school support and a large attendance. For a while after the all-Engineering Open House started, the EE and Engineering Open Houses were held on alternate years. The ME department also held several open houses, with attendances ranging up to 5,000.

The first all-Engineering Open House was held on March 23, 1920, as part of a celebration commemorating the 100th birthday of James Witt. It was quite an ambitious project, with over 60 exhibits and a 20-page program for the show. Dr. L. P. Breckenridge, a professor of ME at Yale and one of the top men in the country in his field, was invited to speak. Another open house took place in 1921, and from then on open houses were a permanent fixture at Illinois. They were held either every two years or every four years until the war interrupted.

As the years went by, the Open House gained more prestige and a new name, the ISEE (Illinois Student Engineering Exhibition). By 1935, the ISEE had developed into the spectacle that it is today. But, as Dean Enger of the engineering college commented, it was not a stunt show, but actually a cultural course in engineering. He said, "The displays are designed to show, in a manner that a layman can understand, some of the basic principles on which the science of engineering is founded."

The 1939 ISEE carried on with the great tradition. Over 10,000 visitors descended on the campus for the weekend. They saw many exhibits which are still remembered. In the locomotive lab, a full-sized engine kept running at top speed without moving an inch. This giant was used in brake shoe research. A new metallurgy lab and an EE demonstration of television were also among the top exhibits of the day.

The war interrupted the presentation of the biennial Open House through its drainage of engineering manpower. The first and only Engineering Exhibit since the war was held on March 31-April 1 of 1950. The stress and strain of 3500 student engineers culminated in an Engineer's Weekend that would have brought pride to the soul of St. Pat himself.

Stemming from the discovery of the Blarney Stone in the murky waters of the mighty Boneyard, the activities continued with an accelerative pace through the presentation of the parade of engineers' floats, the Open House itself, St. Pat's Ball, and the dubbing of the Knights of the Order of St. Patrick. Interspersed throughout these activities was the game of "Blarney, Blarney, Who's Got the Blarney Stone?" as thievery played a repetitive role in the life of that sacred article.

The Open House was a reservoir of engineering ingenuity. Exhibits by the various departments and honoraries showed many facets of mechanized industry. The structure and operation of automobiles and jet-engine airplanes were disclosed and explained. The wind tunnel of the aeronautical engineers was exhibited in actual operation. An impressive test of the breaking of a concrete cylinder by Talbot Lab's 3,000,000 *lb* hydraulic testing machine was shown. Brick making machines, television sets, rock crushing machines, Geiger counters, and traffic counters were among the variety of projects shown in operation.

Among the audience participation exhibits were the driver reaction meter, strength tester, and a lie detector. A "kissometer" was on hand to give ratings of an individual's osculation ability. (The records are not clear on whether a suitable partner was on hand to assist in this measurement).

The wonders of scientific technology were displayed in such mystifying exhibits as the floating dishpan, which was suspended in mid-air with no visible means of support; the ghost writer, in which electrons were harnessed to spell out words; the theremin, which emitted musical tones at the approach of the operator's hands; water boiling in a paper cup; and the color organ, which

(continued on page 32)

Left: Dean Everitt displays the much sought after Blarney Stone.

Above: The IAS prize-winning float. Right: Frankie Master's orchestra provided the music for the 1951 St. Pat's Ball.

— *the university of illinois at . . .*

navy pier

by Warren H. Brandt, c.e. '54

Harvard on the rocks

The week of December 3-7 was an eventful one for Pier engineering and architecture students, with a host of celebrities that would turn a TV emcee to shame.

On Wednesday afternoon Pier architects were treated to a three-hour symposium on Dymaxion philosophy, presented under the auspices of the American Institute of Architects and featuring R. Buckminster Fuller, mathematician, architect, designer and philosopher.

Fuller's philosophy, that of treating a problem as a whole, or looking at all aspects of a situation, enthralled many who heard it, including this editor. The passage of time went unnoticed as this genial man expounded his ideas on the economics of construction and the relation of design to economics.

Those receiving awards and their respective activities are, kneeling left to right: Robert Brittain, AIA; James H. Trail, ASCE; AIEE sponsor W. K. LeBold; Miss Frances Watkins, AIEE and Engineering Council chairman; Ronald Kowalik, AIEE; Charles Kersch, AIEE. Standing, left to right: ASCE sponsor J. C. Chaderton; Dean F. W. Trezise, College of Engineering UIC; IAS sponsor George J. Zanotti; Phillip De Protine, IAS; ASME sponsor J. S. Kozacka; Warren Brandt, ASCE and TECHNOGRAPH; William Kahan, ASCE; Oliver Smith, ASME; Jack Margolis, AIEE; Harry Rogers, ASME; Frank Pease, AIEE; TECHNOGRAPH sponsor Ogden Livermore and AIA sponsor H. B. McEldowney.

Wednesday evening was occupied with the first annual Engineering Societies Council dinner, with Associate Dean of engineering F. W. Trezise as master of ceremonies.

Guest of honor and principal speaker was Ovid W. Eshbach, dean of engineering of Northwestern Technological Institute. His theme was "The Curses and Virtues of Engineering Convention." The 300 engineers present warmly applauded Dean Eshbach as he urged them to be loyal to their profession, their school, and to themselves.

Extending greetings from the Urbana campus was Harvey Jordan, associate dean of engineering who welcomed Pier engineers to visit classrooms and laboratories downstate.

Also present from Urbana were four members of the *Technograph* staff including editor Hank Kalapaca and faculty adviser R. W. Bohl.

Editor Kalapaca outlined the scope of the *Technograph's* field of endeavor, its place as the outstanding engineering magazine of the school and possibilities for the development of journalistic abilities by students who might be interested in joining its staff.

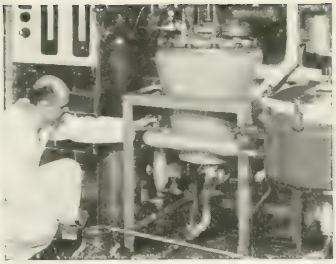
The festivities of the evening closed with the presentation of Certificates of Merit to students in the college of engineering who had done outstanding work in the different engineering societies.

Recipients of awards were the following:

In the American Society of Civil Engineers—Warren H. Brandt, William Kahan and James H. Trail.

In the American Institute of Architects—Warren Anderson and Robert Brittain. (*continued on page 30*)

THE DU PONT DIGEST

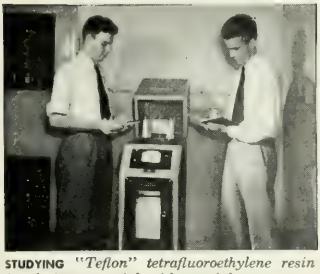


CHEMICAL *engineers supervise preparation of larger-than-laboratory batches of chemicals in Du Pont's Special Service Laboratory.*

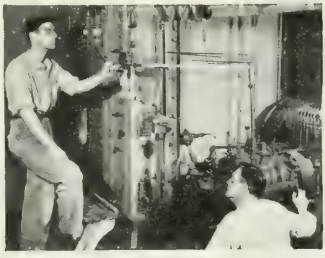
Ch. E's at Du Pont

[FIRST OF A SERIES]

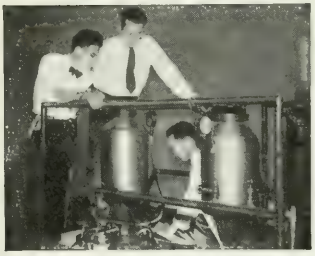
New products mean new opportunities for chemical engineers



STUDYING *"Teflon" tetrafluoroethylene resin insulating material with special apparatus: K. F. Richards, B.S.Ch.E., Cornell '48; and E. K. Holden, M.S.Ch.E., Delaware '48.*



CHECKING *a multi-stage carbon-monoxide compressor used in semi-works operations: R. L. Stearns, B.S.Ch.E., Yale '49; and H. Peterson, B.S.Ch.E., Northeastern University '42.*



CHARGING *experimental polymers to spinning machine: O. C. Wetmore, Ph.D.Phys.Ch., New York U. '44; D. A. Smith, B.S.M.E., Purdue '40; and C. O. King, Sc.D.Ch.E., Michigan '43.*

To you as a student chemical engineer, what does this statement bring to mind:

> **Nearly two-thirds of Du Pont's current sales are in products entirely or virtually unknown in 1930.**

Likely it suggests years of solving intriguing engineering problems, the designing of unique equipment, the carrying out of reactions under extraordinary conditions.

But it should also suggest the opportunities that will come to chemical engineers in the future. For at Du Pont, new and better products are continually being developed. From today's extended program of fundamental research you can expect more neoprenes, more nylons, more plastics like "Teflon" tetrafluoroethylene resin.

As these products come out of the laboratory, they will bring with them a succession of interesting and challenging problems for the chemical engineer. Problems that will arise out of their very newness.

For instance, take nylon, the first wholly synthetic organic fiber. In working out techniques for its commercial manufacture, there was practically nothing to go on. The compounds of which it was made, hexamethylenediamine and adipic acid, were essentially laboratory chemicals. Processes had to be devised to make them from cheap raw materials—benzene, hydrogen, air and ammonia. Large-scale preparation of nylon salt from amine and acid required going beyond the classical unit operations.

Here for the first time it was proposed to extrude a fiber with extreme accuracy from a melted polymer at 290°C. At this temperature the polymer decomposes slowly. It had to be melted, pumped at 5000 p.s.i. pressure through microscopic holes and cooled in a hurry. Otherwise the fiber would emerge discolored.

The Du Pont chemical and mechanical engineers and other men and women who worked with them ran into one difficulty after another. More than once they thought that the project would have to be abandoned.

However, it is basic in Du Pont people's philosophy not only to take on difficult pioneering problems, but to see them through. With nylon, this persistence paid off handsomely.

Is this the kind of problem *you'd* like to attack, the kind of people *you'd* like to work with?

NEXT MONTH — Opportunities for chemical engineers in research and development will be discussed in the second article in this series. Watch for it!

WRITE FOR *40-page booklet, "The Du Pont Company and the College Graduate." Address: 2521 Nemours Building, Wilmington, Del.*

DU PONT

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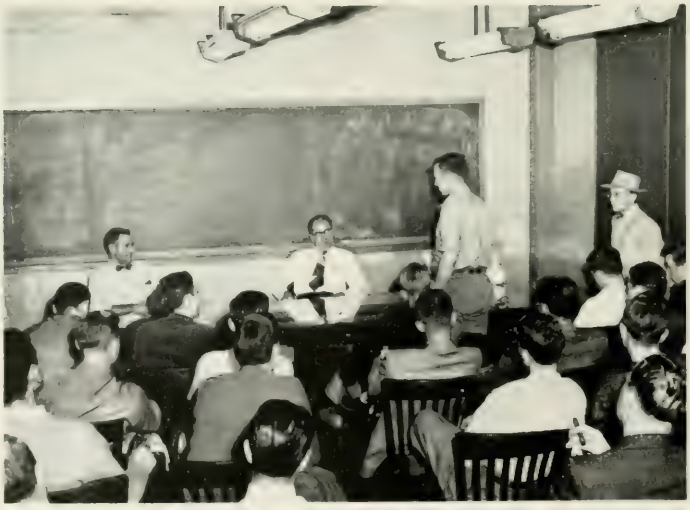
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Entertaining, Informative — Listen to "Cavalcade of America," Tuesday Nights, NBC Coast to Coast

Central Foundry Division

General Motors Corporation

Left: The tour was supplemented with an invitation to dinner in the modern cafeteria which is an integral part of the foundry. Standing in center rear are Plant Manager Martin and Grey Iron Supt. Drury. Jim Leach, A.F.S. adviser is seated behind Drury.



Right: Left to right facing camera: Charles Drury, Grey Iron Superintendent; Tom Cavanaugh, Personnel Manager; A. L. Andrews, student; Dick Martin, Plant Manager, and A. C. Degner, student.

CONFERENCE IN THE CLOUDS

Among the undergraduates on any college campus, you'll find the talk reaching up to the clouds. And once in a while — in a classroom, around a study table, or even in a bull session — a really big idea is born.

Big ideas come, too, from the men and women in laboratories, business offices, shops. But often these professionals are exploring a path first glimpsed in college.

How do we know? Because of the many college people who have come into the Bell System, where big ideas and a lot of dreams have taken their place in progress. The human voice, carried along a wire, first across a town, then a state, a nation, and now the world. Music and pictures and things happening delivered into cities and hamlets all across the land by radio and television networks.

We're always looking for the men and women who get big ideas — whether they're about people, or machines, or ways of doing things. It's the only way the Bell System can keep on giving this country the best telephone service in the world.

BELL TELEPHONE SYSTEM

by Bob Schrader, ch.e. '54

One of the real gems of literature of our time was recently published by *The Benchmark*, official publication of Chi Epsilon, honorary civil engineering fraternity. It is entitled:

THE ENGINEER

Verily, I say unto you, marry not an engineer for the engineer is a strange being possessed of many devils; yea, he speaketh eternally in parables, which he calleth "formulas," and he wieldeth a big stick which he calleth a slide rule, and he hath but one Bible—a handbook.

He talketh always of stresses and strains, and without end of thermodynamics. He showeth always a serious aspect and seemeth not to know how to smile; and he picketh his seat in the car by the springs therein and not by the damsel beside him; neither does he know a waterfall except for its power, nor the sunset except for its specific heat.

Always he carrieth his books with him, and he entertaineth his maiden with steam tables. Verily, though his damsel expecteth chocolates, when he calleth he openeth the packages to disclose samples of iron.

Yea, he holdeth his damsel's hand, but only to measure the friction, and kisses but to test viscosity. For in his eyes shineth a far-away look which is neither love nor longing—but a vain attempt to recall a formula.

There is but one key dear to his heart, and that is the Tau Beta Pi key; and one love letter for which he yearneth, and that an "A"; and when to his damsel he writeth of love and signeth with crosses, mistake not these symbols for kisses, but rather for unknown quantities.

Even as a young boy he pulleth a girl's hair to test its elasticity, but as a man he discovers different devices; for he would count the vibrations of her heart strings and reckon her strength of materials; for he seeketh ever to pursue the scientific investigations, and inscribeth his passion in a formula; and his marriage is a simultaneous equation involving two unknowns and yielding diverse answers.

* * *

A demure young thing walked into a furniture store to buy a piece of furniture for her apartment. "I can't make my mind up. I don't know if I want an arm chair or a davenport."

Said the salesman, "You can't make a mistake with an arm chair. Because when *—the rest of this joke is censored.* For the punch line send a self-addressed stamped envelope to *The Illinois Technograph*, Civil Engineering Hall, University of Illinois.

* * *

POET'S CORNER(?)

I serve a purpose in this school—
On which no man can frown—
I quietly sit alone in class
And keep the average down.

* * *

Sing a song of sulfides,
A beaker full of lime,
Four and twenty test tubes
Breaking all the time.
When the cork is taken out,
The fumes begin to reek.
Now isn't that an awful mess
To have five times a week?

* * *

Little Jack Horner
Sat in a corner,
Crib notes under his eye.
He opened his book,
Took a quick look,
And now he's Tau Beta Pi.

* * *

VISIT THE '52 OPEN HOUSE

* * *

An EE professor was explaining a fundamental concept of electricity. "Let's take a positive charge and put it in Talbot Lab. Then let's take a negative charge and place it in the Law Building. Come to think of it, what the hell's a negative charge doing in the Law Building?"

A patient at a mental hospital who had been certified cured was saying goodbye to the head psychiatrist.

"And what are you going to do when you get out into the world?" asked the doctor.

"Well, I may go back to Illinois and finish my engineering course. Then, I liked the Army, so I may enlist again."

He paused a moment and thought. "Then, again, I may be a teakettle."

* * *

The moon was yellow,
The lane was bright,
She turned to me
In the autumn light.
And with every glance
She gave a hint
That what she craved
Was real romance.
I stammered, stuttered,
And time went by.
The moon was yellow
. . . And so was I.

* * *

Dr. Ehrensperger: "Are you sure that this story is original?"

Student: "Absolutely, sir."

Dr. Ehrensperger: "To think I should ever have the pleasure of meeting Rudyard Kipling in person!"

* * *

"Whoever told that guy he was a prof? He just doesn't know how to teach the stuff. Everybody hates him. Every time he tries to explain something he digresses so much that no one can understand what he's talking about. I think he ought to quit teaching and go back to the farm."

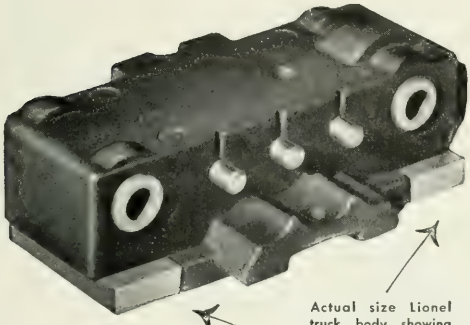
"Yeah, I flunked, too."

* * *

There was a young girl from
St. Bride's
Who ate green applies and died
Within the lamented
The apples fermented
Making cider insider insides.

What's Happening at CRUCIBLE

about permanent alnico magnets



Actual size Lionel truck body showing two Crucible alnico bar magnets in place.

Lionel uses Crucible Alnico in new locomotive design

The Lionel Corporation, big name electrical toy manufacturer, has pioneered in the design of miniature locomotives for table-top railroading. One of the principal aims of this design is to achieve the highest possible degree of adhesion between the driving wheels and the track.

Lionel experimented with a conventional method of increasing the traction (i.e. load up the driving axles with ballast weights) . . . and then turned to magnetic materials.

Crucible alnico specialists were called in. Working in close cooperation with Lionel engineers, the Lionel "Magne-Traction" locomotive was born. As the name implies, "Magne-Traction" utilizes magnetic attraction between powerful Crucible alnico bar magnets placed in close proximity with the wheels.

By varying the number and strength of the magnets, almost any desired degree of adhesion can be obtained. In laboratory tests a light-weight plastic "Scout" locomotive whose normal train load is 4 cars, was able, after installation of proper magnets, to pull a train of 24 cars, an improvement of 600%. A heavy miniature locomotive

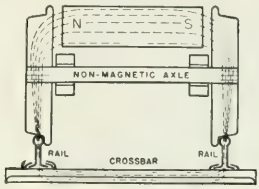


Diagram shows how magnetizing force is supplied by external stationary Crucible permanent magnet and non-magnetic axle. Wheels are sintered steel.

pulled 28 cars instead of its usual load of 7 cars. Then too, locomotives unable to start a normal 4 or 5 car train on greater than 1 degree slope were able with the special magnet assembly to pull them from a dead start up a 5° slope, while the new twin-motor Lionel Pennsy GG-1 scooted up a 15° slope (i.e. 37% grade) without any apparent difficulty.

Crucible's part was twofold. Not only were Crucible metallurgists and engineers active in the initial design, but Crucible production experts precision cast these bar magnets using plastic patterns. This is an innovation in alnico magnet mass production. Commonly, alnico is made in sand molds, and usually requires a great deal of finishing, but with precision-cast alnico magnets expensive machining is cut to a minimum.

Engineering Service Available

Your permanent magnet problem will receive the same experienced consideration from Crucible's unsurpassed staff of metallurgists and production specialists. Please give full details. Crucible Steel Company of America, General Sales Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

52 *years of* Fine *steelmaking*

Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

skimming industrial headlines

edited by Howie Hadler, ag.e. '54

spiral lighting arrester

Shown here is a model of a new high voltage lightning arrester with its designer, A. M. Opsahl of Westinghouse. Only half as tall as former high-voltage arresters that required large structural steel supports, the new type SV station type arrester features a zig-zag arrangement of the arrester units that eliminates the need for such supports. Lightning surges are carried groundward through a series of arrester units that spiral down between the three vertical columns. For use on 230-kv lines, the arrester stands ten feet high, and is more efficient, less costly to install, and more easily maintained than previous designs of high-voltage arresters.

lights for Lyndonville

Lyndonville, Vermont, a Green Mountain ski resort town, has established itself as the only town in the country with a fluorescent-lighted main street.

Each of the new units, of which there are ten, contains four lamps, and has a total output of 22,000 lumens. The big (8 *ft*) fluorescent lamps will give a brighter and more diffused light than the globe fixtures which they replace.

The installation is made on aluminum poles 30 *ft* high, in a staggered arrangement calculated to provide an average illumination of one foot-candle.

So effective are the fluorescents in lighting the center of the town, that officials of the community plan to hold their famous sled dog races right down the main street this winter.

plastic blowers for A-C motors

Plastics has found another use in the electric motor field, where it is now being used to replace critical aluminum and bronze for blowers in small, totally-enclosed, fan-cooled a-c motors. The plastic blowers consist of a polyester resin reinforced with glass fibers. Glass fiber reinforcement has been found to be superior to organic fiber reinforcement because of increased resistance to chemical attack, and increased strength per pound.

The plastic blower has many advantages over the aluminum and bronze blowers it replaces. It is desirable on motors used in refineries, chemical plants, and process industries where corrosive atmospheres may be present, since it is unaffected by the chemical agents that attack the metal blowers.

The plastic blower is as much as one third lighter in weight than its metal counterparts. While this may be only a few ounces, the reduction of inertia where frequent, rapid reversals is required is worthwhile. Preliminary tests indicate that the plastic blower has better resistance to abrasion than its predecessors. All these advantages are obtained without sacrifice in blower performance. The new type blower has successfully passed over speed tests at four times normal speed.

cleaning by sound

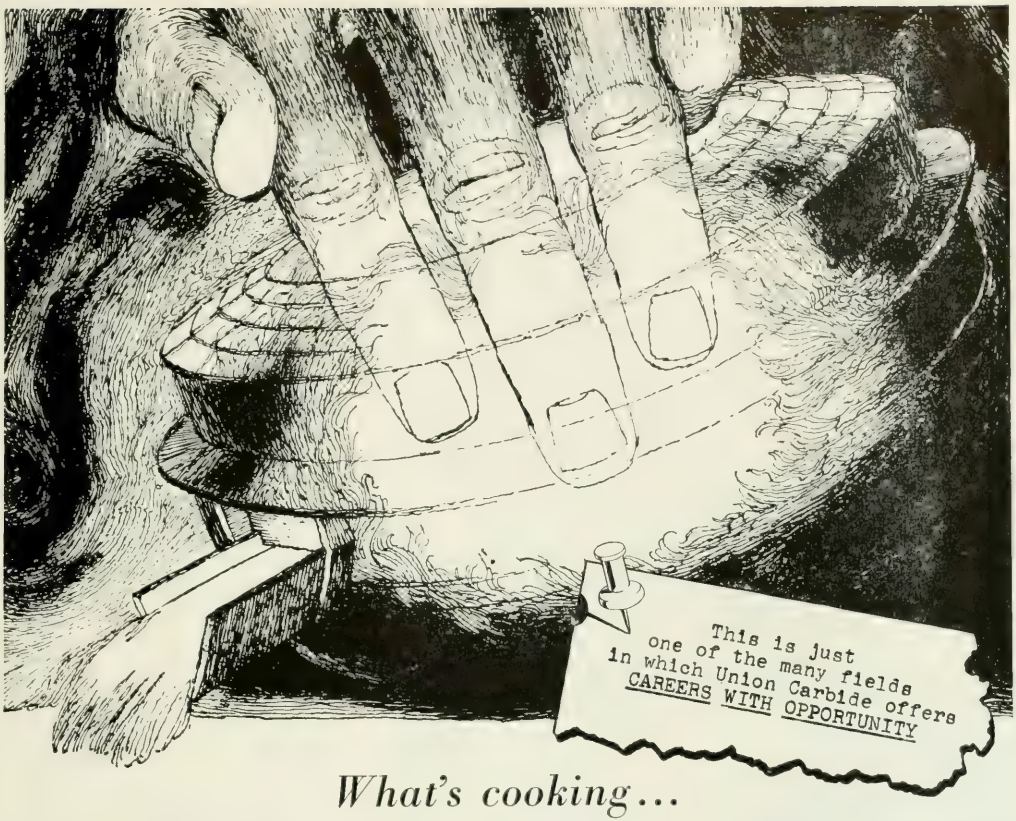
Sound pitched so high that it cannot be heard is now being used, for what is believed to be the first time, in industrial cleaning on a production line basis.

By means of an ultrasonic cleaning machine, high-pitched sound waves directed through a liquid solvent silently remove metal particles, lapping compound, oil and grease from tiny openings and corners of electric shaver heads.

The device was developed by GE and is now in use by Schick Incorporated, manufacturers of electric shavers.

Cleaning of the tiny openings in shaver heads has long been a major problem in the electric shaver industry, previous methods requiring long, tedious operations. Special compounds used in grinding, as well as metal particles resulting from grinding, become lodged in the small corners and capillary spaces of shaver heads, making cleaning difficult.

Plastic blowers for use on small fan-cooled a-c motors shown with older type aluminum and bronze blowers which they are replacing. (Courtesy of Westinghouse)



What's cooking...

From the raging heat of this furnace come basic materials for your stainless steel kitchenware, plastic shower curtains, and man-made textiles

What's cooking in the seething, roaring fire of this electric arc furnace?

The fingers? No! They represent what's doing the cooking.

WHITE-HOT INFERNO—In the actual furnace the fingers are giant rods of carbon or graphite, called electrodes, that carry the heat-creating electricity. Carbon and graphite are the only materials that can do this and stand up under the terrific temperatures of 6,000 degrees or more.

In carbon arc furnaces, alloy metals used in producing stainless steel are separated from their ores. Similar furnaces are used to make other tough and hard varieties of fine steels for automobiles, airplanes and many other familiar products.

SERVES YOU MANY WAYS—But steel making is only one important way in which carbon and graphite serve you. Motion picture screens are illuminated by the brilliant light of the carbon arc. Calcium carbide, the source of many modern plastics, textiles and chemicals is an electric furnace product. Without carbon we wouldn't have dependable, long-life dry batteries for flashlights, radios and hearing aids.

WORK OF UCC—Creating carbon and graphite products for an almost endless number of uses is one of the many accomplishments of the people of Union Carbide.

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Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of ALLOYS, CARBONS, CHEMICALS, GASES, and PLASTICS. *Ask for booklet N-2.*

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EVEREADY Flashlights and Batteries • PRESTONE and TREK Anti-Freezes • BAKELITE, KRENE, and VINYLITE Plastics

introducing . . .

by Tom Tucker, ch.e. '53 and Bob Dreshfield, met.e. '55

BILL SODERSTROM

Bill Soderstrom, who graduated from high school in Grand Junction, Colorado, was born in 1927 in Rapid City, South Dakota. He moved to Grand Junction at the age of three, where he has resided since.

Bill is studying ceramic engineering, although he spent two years with the Navy as a radio technician and sonar

BILL SODERSTROM

instructor. He attributes his interest in ceramics to the fact that he worked for the Grand Junction Brick Company for several years.

Bill spends most of his spare time working for the Illio, for which he is assistant editor. He got his start in college publications writing for the *Tech*.

This busy gentleman also finds time to be president of his social fraternity, Phi Kappa Sigma. He is treasurer of Keramos and a member of Tau Beta Pi, Tomahawk, Student Chapter American Ceramic Society and recently attended the "100" Banquet for the top one hundred seniors in activities.

After graduation in June, 1952, Bill will return to Grand Junction, Colorado, where he has a job awaiting him as a ceramic engineer with the Grand Junction Brick Company.

ROBERT W. BOHL

Robert W. Bohl, assistant professor of metallurgical engineering, was mined in Peoria in 1925. Preliminary treatment of the ore was carried out at Peoria-Woodruff high school. For one year, refining was carried on at Bradley university. However, the job was then transferred to the University of Illinois. In 1940, the University considered the product worthy of the degree of Bachelor of Science.

After receiving his degree, Mr. Bohl joined the staff of the U. of I. and has remained ever since. Three of his summers have been spent in the Caterpillar research laboratory studying aluminum piston alloys. In 1949, the University conferred both a masters degree and

ROBERT W. BOHL

an assistant professorship on him. At present, he has passed the preliminaries for his Ph.D., but has not finished the research.

This past semester, Mr. Bohl taught ferrous metallography, non-ferrous metalography, ferrous process metallurgy, and mechanical metallurgy. He states that he likes teaching at the University very much. He is also a member of the policy and development committee of the college of engineering.

Mr. Bohl was married in 1947 and at present has one daughter, 18 months old.

This fall he wrote an article for the *Welding Journal* with some members of the department of civil engineering.

As an undergraduate, Mr. Bohl was a business manager of the *Technograph*. His name has reappeared on the masthead this year. He now is a faculty adviser.

While attending the University, Professor Bohl gained entrance to Tau Beta Pi, Sigma Tau, Alpha Sigma Mu, Phi Kappa Phi, Sigma Xi, and a mathematics honorary.

For relaxation, Mr. Bohl likes to watch basketball and football, and to play handball and tennis. Another hobby is photography. This latter ties in well with work in a metallurgy laboratory, according to him. He also puts out a newsletter to the alumni of the metallurgy department.

"I'm sorry to disappoint you, Charles, but I can't go out with you tomorrow. I became engaged to Dick last night."

"Oh, well, how about next week?"

* * *

Little Jerry came down the stairs bellowing lustily. "What's the matter now?" said his mother.

"Papa was hanging pictures and he just hit his thumb with the hammer," said Jerry.

"That's not so serious," soothed his mother. "A big man like you shouldn't cry at a trifle like that. Why didn't you laugh?"

"I did," sobbed Jerry.

* * *

A conductor fears no one—he tells 'em where to get off.

* * *

"Mmmmmm.I guess I've lost another pupil," said the professor as his glass eye rolled down the sink.

* * *

The one ring circus was visiting a town in the hills. The folks there recognized all the instruments of the band except the slide trombone.

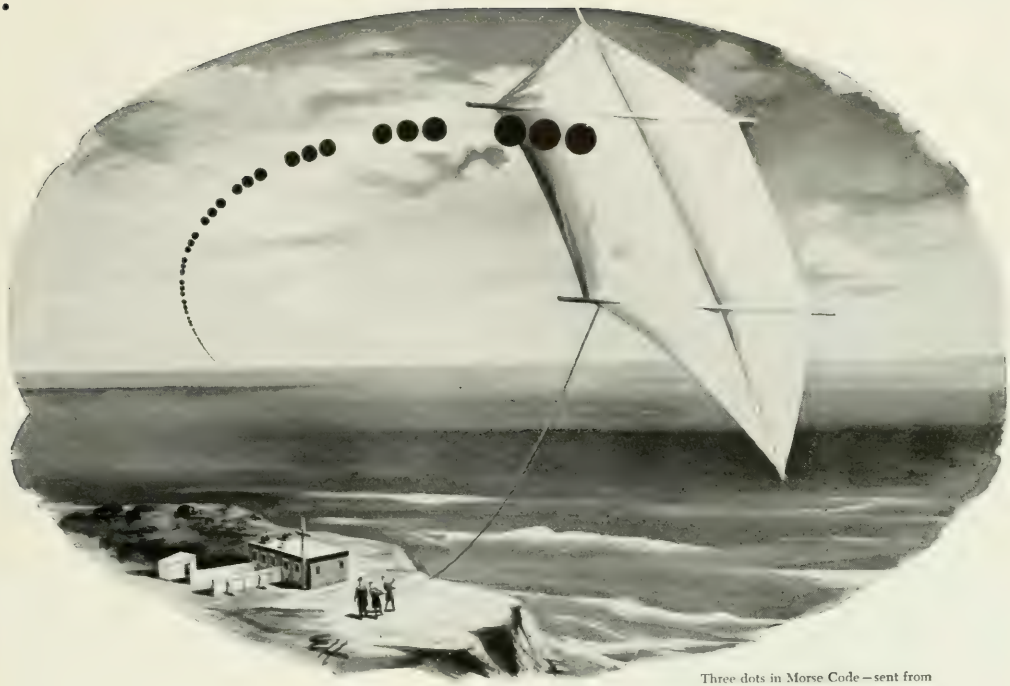
One old settler watched the player for quite some time, then, turning to his son, said, "Don't let on that you're watching him. There's a trick to it; he ain't really swallerin' it."

* * *

The landlady was showing a prospective tenant a room. "I think that I ought to tell you," she said, "that the former occupant of this room was a Professor Steinway—an inventor."

The man stood silent for a moment, then, noticing a rather large stain on the ceiling, he remarked: "One of the professor's experiments?"

"Heavens, no!" exclaimed the landlady. "That's the professor."



Three dots in Morse Code—sent from England and received by Marconi in Newfoundland—proved that wireless signals could span the Atlantic.

Three dots that opened a new era!

When Marconi, on December 12, 1901, heard a "3-dot" radio signal—the letter "S" in Morse Code—across 1,800 miles of sea, it was an experimental triumph that opened a new era in communications.

Before this historic event, wireless telegraphy had been limited primarily to communications between the shore and ships at sea. Marconi's success, however, was the forerunner of many other developments which led eventually to RCA world-wide radiotelegraph service that now operates more than 80 direct circuits to 67 countries.

As radio progressed, its usefulness was expanded by invention and development of the electron tube, the harnessing of short waves which made world-wide transmission a reality, and the automatic transmission and reception of messages at high speed.

Radio, with its magic of spoken words and music broadcast over the world . . . *television*, the miracle of pictures in motion transmitted through the air . . . these mediums of modern communications have added notable links in the chain of electronic advances first forged in 1901 from the mere sound of three dots.

* * *

See the latest wonders in radio, television, and electronics at RCA Exhibition Hall, 36 W. 49th St., N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y.

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- Design of component parts such as coils, loudspeakers, capacitors.
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- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey. **Also many opportunities for Mechanical and Chemical Engineers and Physicists.**

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CENTRAL FOUNDRY . . .

(continued from page 9)

trains in the foundry have been carefully engineered by the methods department.

To illustrate the unit function of this foundry, let's follow the average production job through the malleable iron wing of the plant. The primary step is the manufacture of cores to be used in the molding process. Core sand, to be used in this operation, is brought to the storage house in railway cars where it is dried and stored, according to

Mr. Dick Martin, recently appointed Plant Manager, now holds full responsibility for the operation of the Danville Plant.

specification, until it is needed within the system. From the storage house, the sand enters the core room by an overhead belt and is automatically weighed into the mullers. Near the mullers, dry ingredients, including corn flour and bentonite, are weighed on a small batch scale and, with oil and water, are metered into the mullers. The moist mixture is prepared in mullers with automatic timing devices. When the mixing cycle is completed, the prepared mixture is conveyed by continuous belts and an elevator to the second floor storage bins from which gasoline powered wheelbarrows take their loads of core mix to feed the hoppers above the core machines. To avoid piping stoppages, vibrating feeders are used on these hoppers.

Automatic core blowing machines are used, and are of three different sizes to facilitate the desired flexibility in production. A roll-over machine is also used. After the machines, fed from the hoppers above, have filled the permanent metal core boxes, the cores are switched to the driers and put on the oven conveyer rack. The cores then pass into the oven and are baked at a temperature of 450 to 500 F for a period of approximately one hour. After baking, the conveyor progresses to the "dry side" of the core room where the cores are inspected and processed.

A special unit is provided for the preparation of the molding sand. In this unit, sand from the shakeout has moisture, new sand, sea coal, and a bonding agent added to the desired proportions. The mix is mulled and delivered by overhead belt system to the tempering bins. Molding sand is then delivered to the molding machines as needed by an overhead belt system.

In dominance are jolt squeeze type molding machines. The assembly line technique is utilized effectively here. As a continuous conveyor containing empty flasks passes the line of molding machines, the operator of the machine removes the flask and swings it onto his molding machine where the flask is charged and the drag made. The flask is then replaced upon the conveyor with a crane. This operation takes place at the drag station. Core setters then place the cores in the drag portion of the mold as it progresses along the conveyor. At the cope station, the cope is made upon a molding machine and placed by means of a crane upon the drag portion of the mold. The mold now need only be aligned and clamped and it is ready for pouring. A continuous conveyor transfers the completed mold to the pouring area.

Thus far, the operations in both grey and malleable iron sections have been very similar, but here the differentiation begins.

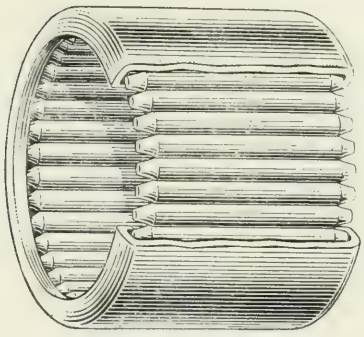
Malleable Iron Castings

First, let's complete the malleable iron cycle. The melt must now be readied for pouring. Ingredients, as predetermined by experience based upon test laboratory data, are carried to the charging floor of the cupola; the scrap steel, sprue, and pig iron being retrieved from the outside storage area by cranes equipped with electromagnets.

Men weigh the ingredients comprising the charge, and then dump them through the charging door from hand trucks. The white iron melt is tapped from the forehearth of the cupola and transferred to an electric arc furnace where chemical and physical properties can be checked and controlled an the temperature increased. From the electric furnace, a large monorail delivery ladle transfers the melt to the pourers who run their swivel ladles on a monorail parallel to the mold conveyor. The conveyor system then leads to the shakeout where castings are removed from the molds and placed into cooling buckets which traverse the width of the foundry on an overhead conveyor system. The semi-cool castings are dumped on a sorting belt where they are separated into bins on an inclined slide. At this point, obviously, faulty castings are allowed to pass on to the scrap pile.

The white iron castings then go down a slide where chipping is done to ready them for the annealing oven. When chipped, the castings are transferred to trays and sent to their 35 to 40 hour run in the annealing oven. Here, the white iron is transformed from free cementite in a matrix of pearlite to temper carbon in a matrix of ferrite, which is malleable iron. Upon removal from the annealing oven the malleable iron castings are cleaned in a shotblast cabinet and further processed. This final processing may

(continued on page 24)



This is a Torrington Needle Bearing

Designed for Today's Needs and Tomorrow's Trends—
Needle Bearings Offer A Unique Combination of Advantages

The Torrington Needle Bearing has two component parts—the full complement of relatively small diameter, thru-hardened, precision-ground rollers and a case hardened retaining shell by which they are held.

The bearing is a complete unit in itself, and is easily pressed into position in a bore machined to proper dimensions. The advantages of this unit construction in simplifying installation and speeding assembly are readily apparent.

High Radial Capacity

Of special importance is the high capacity of the Torrington Needle Bearing. This efficient anti-friction unit can carry a greater radial load than any other bearing of comparable outside diameter due to the large number of rollers. The small cross section of the bearing allows a large shaft which permits a rigid design with minimum shaft deflection.

Efficient Lubrication

The method of lubrication is another feature of the Torrington Needle Bearing. The retaining shell with its turned-in lips provides a natural reservoir for the lubricant. Thus the needle rollers turn in an oil or grease bath and continually bring up a fresh film of lubricant—insuring rotation of all moving members on a fluid film.

Low Cost

The size of the Torrington Needle Bearing, coupled with the simplicity of its construction, makes it a comparatively inexpensive anti-friction unit. Its compact size encourages simplified design which requires less material in surrounding components. This also contributes to further cost reductions.

The shaft serves as the inner race in the majority of Needle Bearing applications and therefore should be hardened and ground to proper dimensions. However, where it is desirable to use an unhardened shaft, an inner race can be supplied.

For Modern Design

Where the efficiency of anti-friction operation is desired, and where space, weight and cost are vitally important considerations, Needle Bearings provide a logical answer. That's why you will find them used in an ever-growing list of applications.

This is one of a series of advertisements designed to give you the latest engineering information on Needle Bearings. Should you have occasion to work with bearing design or wish more information, write our engineering department.

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TORRINGTON *NEEDLE* **BEARINGS**

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS

CENTRAL FOUNDRY . . .

Continued from page 22

include inspection, gauging, shearing, grinding, pressing, and burring, or any combination within the group.

The castings are then transferred to the shipping area where they are counted, weighed, and readied for shipment.

Grey Iron Castings

Unlike the malleable iron foundry, the grey iron foundry pours the melt directly from the forehearth of the cupola into the monorail delivery ladle, from which the pourers receive their charge. The processing of the castings in the grey iron plant is almost identical to the malleable foundry process with the modification of the annealing cycle and pertinent operations. Throughout both foundries, close check is kept upon core sand, and molding sand is tested for moisture and permeability every hour. Iron uniformity is assured by similar means.

The whole operation in both foundries is done as swiftly, cleanly, and efficiently as the best industrial machinery and talent can insure. A General Motors Corporation policy is well reflected in this last statement, for there is a constant effort upon the part of the personnel department to maintain a high level of incoming employees who can insure further development and more efficient production methods in the years to come.

Employment and General Motors

General Motors for many years has developed, from within the framework of the organization, employees for position of responsibility. Obviously, this procedure may best be maintained by the choice of young men with ability and potential. This requirement is fulfilled by people from within the ranks of the organization, college graduates and other technically trained personnel.

In following their college relation activities, Central Foundry contacts all colleges within several hundreds of miles to supplement the General Motors Institute Training Program with graduates indicating interest and ability in industrial work. In addition to the regular training program the newly hired graduates undergo, the Central Foundry Division takes selected trainees for summer work which is calculated to give as much experience as possible in foundry techniques.

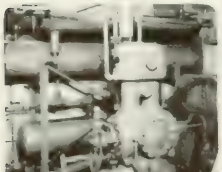
As an employer, GM has taken an active interest in the welfare and protection of its employees. The General Motors' Group Insurance Plan, open to all employees, offers three types of protection at very low rates.

A comprehensive retirement plan provides for continued security in later life. Further economic security is offered by the separation allowance plan which provides financial assistance to employees who have been separated due to conditions beyond their control.

Central Foundry Division of General Motors is a growing plant which offers opportunity, valuable training, and salaries comparable to any other industry within this area. Those of you who would like to add your talents to the staff of General Motors Corporation, Central Foundry Division, may find a rewarding future. The personnel department, in any case, will welcome inquiries from those of you who are interested in working and learning within the General Motors Corporation.

The Shamrock at Houston Uses FRICK Ice-making Equipment

One of 1100 Rooms at the Shamrock



Frick 7 by 7 Compressor

This new 21-million-dollar hotel relies on its Frick machinery to produce 15 tons of clear ice a day.

Just as the U. S. Army, in World War II used Frick 15-ton ice plants by the hundreds, and installed them all over the world. Still buying them, too.

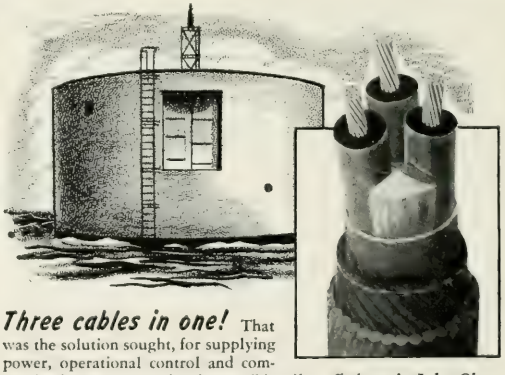
The Frick Graduate Training Course in Refrigerating and Air Conditioning, operated over 30 years, offers a career in a growing industry.

DEPENDABLE REFRIGERATION SINCE 1853

FRICK & CO.

WAYNESBORO, PENNA., U.S.A.

Also Builders of Power Farming and Sawmill Machinery



Three cables in one! That was the solution sought, for supplying power, operational control and communication to a pumping house 4½ miles off shore in Lake Okeechobee, Florida.

As usual, Okonite engineers were consulted on the problem. Their studies showed that it was possible to combine a three-fold function in one cable. This was accomplished by the use of Okolite high-voltage insulation whose electrical characteristics permitted carrier current to be superimposed on the power conductors.

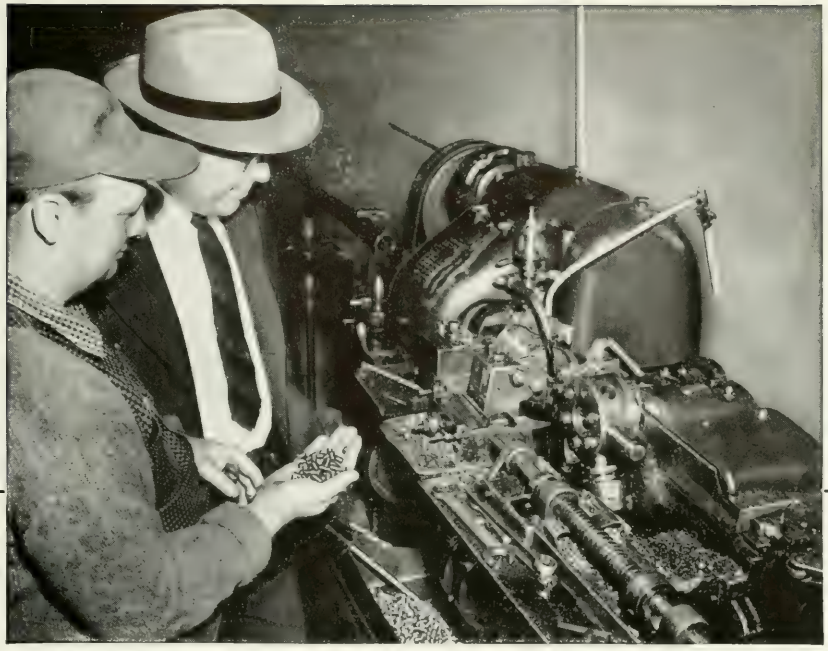
The result was a single Okonite-insulated cable — steel-armored for the 4½ underwater miles, with a non-metallic sheath for an additional 2½ miles underground — which supplies not only power and operation control, but a communication circuit as well.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE insulated wires and cables

8787



RALPH HANSEN of Green Bay, Wisconsin, a Standard Oil lubrication engineer, consults with the operator of a midwest machine shop. His recommendation lengthened by 50% the life of the cutting tools used in the automatic screw machines. The longer period between shutdowns meant higher production levels.

How lubrication engineers help save industry's costliest commodity

IN TODAY'S RACE for greater production, time has become one of industry's costliest commodities. Save time and you save real money. The right cutting oil enables tools to hold their edge longer, and also lets them cut faster while they are at work. These savings in time are a significant contribution to American industry's race with civilian and preparedness requirements.

Such was the contribution made by Ralph Hansen. And it is just one example. Standard Oil's lubrication engineers daily help maintain production capacity in many industries. They are college-trained men with advanced study in Standard Oil's own lubrication engineering school. So, they are equipped to help solve a great variety of problems—involving not only machine tools but also diesels, turbines, gear drives, electrical machinery—just about everything. They deal with equipment working under extreme heat, cold, moisture. They help select cutting oils, drawing compounds, and tempering oils.

New machines and new operations create new lubrication problems. Ways must also be found to keep old machines at peak performance. Here is a real challenge to lubrication engineering know-how.

Standard Oil lubrication engineers take real pride in their training and experience which enable them to make countless contributions to the smooth running of the national economy.

Standard Oil Company

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STANDARD

M. E. DEPARTMENT . . .

(continued from page 7)

plays a very important part in their lives.

Research

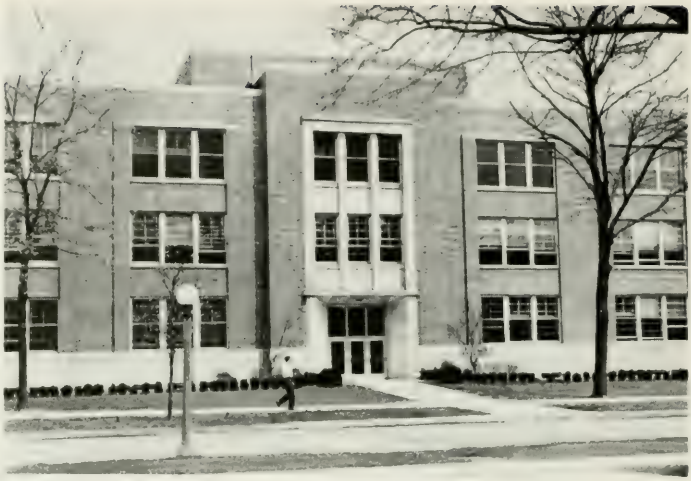
Research has been of paramount importance at the University of Illinois ever since the Engineering Research Station, the first of its kind in existence, was established here in 1903. It is the general policy of the M. E. department to undertake research only on those projects which appear likely to add knowledge in specified areas of engineering. The cost of research is shared by the University and one or more outside sponsors. Over any length of time, more than one-half of this total cost is provided by the outside sponsors.

Through the years, research has been carried on in numerous areas of mechanical engineering. Some of the present or most recent areas include: warm air, steam, and hot water heating; internal combustion engines; flow of fluids; smokeless combustion of bituminous coal in hand-fired furnaces; ventilation; metal cutting; and the effect of atmospheric environment on human beings and animals.

Warm air furnace research is one of the oldest fields in which research is currently being conducted by the M. E. department. This cooperative investigation with the National Warm Air Heating and Air Conditioning Association has been in continuous operation since 1918. Recent activities in this field have been principally conducted in the two research residences erected in 1947 and 1949. Also the department has available for its use a third research residence, a floor slab laboratory, and a mobile testing laboratory. Typical of research in this field was the work done last year to determine the performance of a heating system with the furnace located in an enclosed furnace room or closet. A study was made for different arrangements of supplying combustion air into the enclosure and for ventilating it.

The residence built in 1949 has been used for perimeter warm air heating investigation since shortly after its construction. In the summer of 1950, alterations were made so that four different arrangements of ducts could be studied alternately throughout the 1950-1951 heating season. During that heating season, a great amount of valuable information was obtained which is being used in the design of perimeter warm air heating systems for small houses.

A unique group research program is now being conducted with the cooperation of other departments of the University and the College of Medicine in Chicago. This program is concerned with the study of the effect of atmospheric environment on human beings and animals. The center of this work is the physical environment laboratory located in the mechanical engineering laboratory building. Here physical facilities are provided for the control of the temperature, pressure, humidity, cleanliness and motion of air over sufficient ranges to cause physiologic stress in humans and animals. Although this type of research has been carried on since 1935 at the University's Medical Department in Chicago, extensive facilities on the Urbana campus were not installed until recent years. In its comparatively short life span, the environment lab has already been put to good use by several departments of the University.



The new ultra-modern Mechanical Engineering Building completed in 1949 at the corner of Green and Mathews.

An example of the type of work conducted in the environment lab is that done by the Institute of Aviation in the school year 1950-1951. Six simulated flights to an altitude of 15,000 *ft* were made as a demonstration of the use of oxygen to students in the Institute's pilot training courses. Ten similar flights were made in connection with the study of a possible new method for early recognition of impraised circulation. This group research program, which has been actively participated in by the departments of physiology, psychology, physical education, and aviation, displays the need for persons trained in both the biological and technological sciences.

Another very different type of research, which was started in 1948 for a period of one year and has been continuously renewed since then, is the study of the economic effects of the use of friction-type bearings on the railroads of the country. Taking part in this program are the Timken Roller Bearing Company, the M. E. department, and the college of commerce. Aside from these three active participants, several large rail lines are providing the huge amounts of information needed which can be obtained only from the railroads' files.

The work done thus far has been limited to friction bearing operation on freight cars only. The first topic studied was the total cost of all supplies, maintenance, delays, and accidents traceable to the use of friction bearing cars. Other topics under study are tonnage limitations due to low temperatures, bearing limitations in high speed service, and loss of perishable freight due to bearing trouble. Under the most intensive study so far has been the Illinois Central Railroad, where 2,375 cars were investigated. The Great Northern was selected as the second road for study because of its northerly location; it will be followed by the Santa Fe, a road which experiences converse weather conditions. It is felt that the massive amount of data obtained from this project, when evaluated, will provide priceless information to the industries involved and will allow them to pass on to the general economy savings many times as great as the research cost.

The M. E. department feels that research and education must not be separated and therefore strongly encourages research staff members to do some teaching, and instructional staff members to participate in research part time.

Facilities

Everyone knows that to conduct re-

(continued on page 28)

What decides wages?

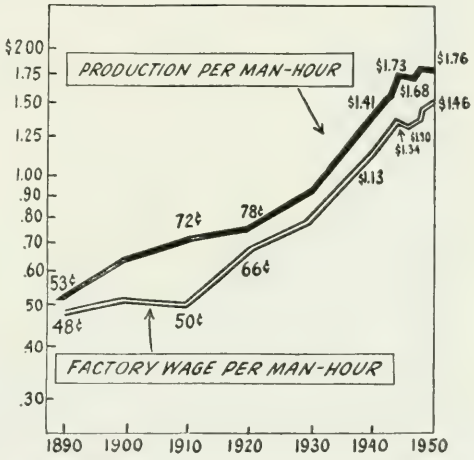
What you and I produce

THERE IS ONE RULE OF NATURE that all the governments, laws, unions and contracts cannot change: a man can be paid *only* out of what he produces, and the more he produces the more he can earn.

AND, that line "Factory wage per man-hour," shown in the chart at right, has gone up and up only as American business has put better and better *machines* to team up with American workers. *Machines* help the worker produce more and so earn more.

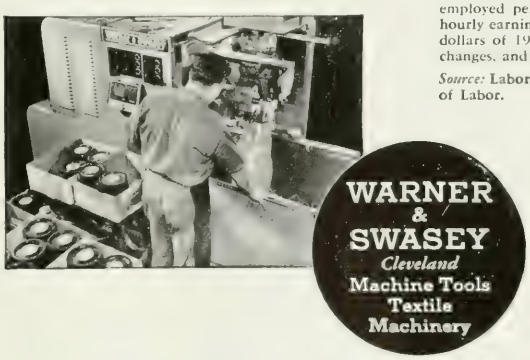
And *machines* can come only from the savings of investors—the savings made out of investor profits.

So—profits plus machines plus workers who use them well, equal constantly rising savings and standard of living. Whoever attacks *profits* is attacking *you,* and your family. Never forget it.



Production per man-hour represents the total national income produced per man-hour worked by all employed persons. Factory wage represents average hourly earnings of factory workers. All figures are in dollars of 1950 buying power to eliminate price changes, and show real purchasing power.

Source: Labor's Monthly Survey, American Federation of Labor.



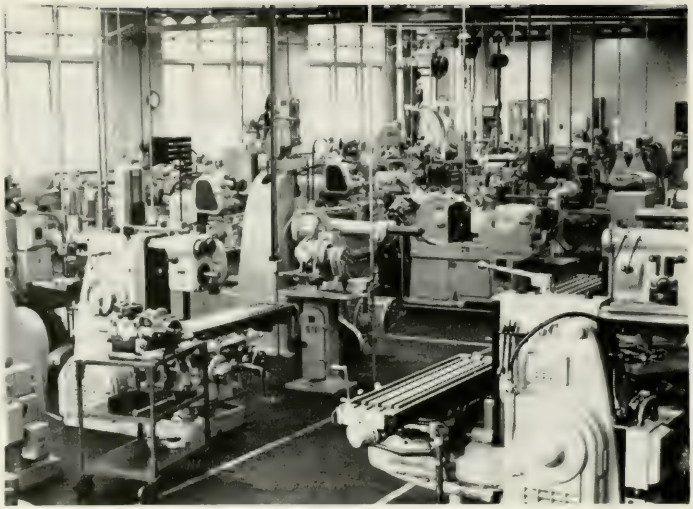
YOU CAN MACHINE IT BETTER, FASTER, FOR LESS WITH WARNER & SWASEY TURRET LATHES, AUTOMATICS AND TAPPING MACHINES

M.E. DEPARTMENT . . .

(continued from page 26)

search effectively many types of equipment are needed. Also necessary are the men to operate that equipment and evaluate the data compiled. The M. E. department rates high on both of these counts. With the opening of the new building at the corner of Mathews and Green in 1949, a tremendous expansion of both research and teaching facilities was made possible. This ultra-modern building contains over 87,000 square feet of usable floor space which includes 16 laboratories, 13 class rooms, 7 design rooms, 5 lecture rooms, and 46 offices.

Among the largest and most fully equipped laboratories in the internal combustion laboratory located in the M. E. building. This lab contains ten dynamometers for engine testing, all of which are capable of operating at speeds up to 6000 *rpm*. A complete set of electronic instruments is also available for determining vibration characteristics, pressure changes, and combustion and detonation phenomena. One dynamometer when used with aircraft engines can be arranged so that intake and exhaust pressures may be made to simulate adverse altitude conditions. Some of the other large laboratories are the power laboratory, machine tool laboratory, and thermodynamics laboratory.



Room 217 of the new M.E. building contains more than one hundred machine tools and is designated the Machine Tool Laboratory.

Staff

Several famous and illustrious men have served on the staff of the M. E. department. Among these is Dr. A. C. Willard, who has been with the University of Illinois since 1913. He has indeed had a very colorful career starting in the heating and ventilating branch. He headed the M. E. department from 1920-1934, acted as head of the college of engineering for two years, and then served in the capacity of president of the University from 1934-1946. Frequently Dr. Willard was employed as consulting ventilation engineer on important jobs such as the Holland Tunnel and the Chicago Subway. The lounge on the main floor of the M. E. building is dedicated to this outstanding staff member who now holds the title of president and professor of heating and ventilating, Emeritus.

Today the M. E. department is headed by Dean N. A. Parker. Dean Parker, who was educated at the University of Colorado, served on the mechanical engineering staff there the greater part of the interim between 1930 and 1946. During that time he took on many interesting and important side jobs among which was the designing, building, and testing of a two-place aircraft for the Combs Aircraft Corporation in Denver. While at Colorado, he designed and built the University's wind tunnel.

Since attaining his position at Illinois, Dean Parker has done a great deal toward the advancement and enlargement of the M. E. department. The revision and addition of courses, along with the inauguration of the option system, have all been done in line with the general opinion that engineers of today can enhance their chances for a successful career by following a well planned educational policy.

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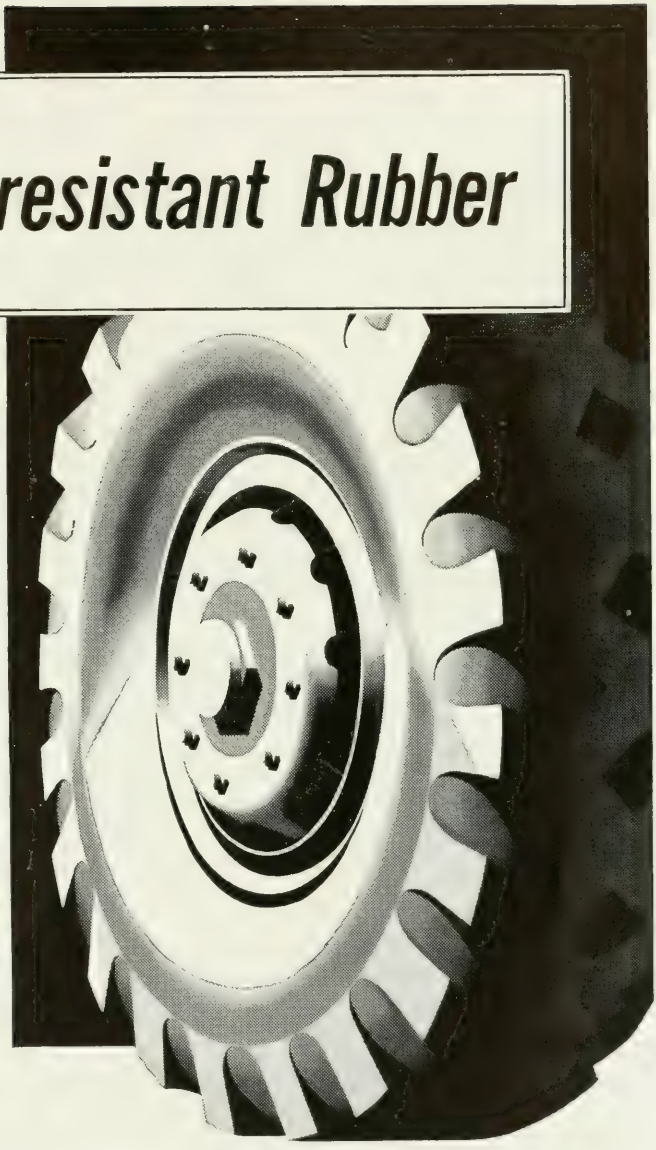

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NAVY PIER . . .

(Continued from page 12)

In the American Institute of Electrical Engineers—Charles Kersch, Ronald Kowadlik, Jack Margolis, Vito Minerva, Frank Pease and Frances Watkins. Miss Watkins is chairman of the Engineering Societies Council.

In the American Society of Mechanical Engineers—Harry Rogers and Oliver Smith.

In the Institute of Aeronautical Sciences—Phillip De Protine.

On the Technograph—Warren H. Brandt.

Another feature of the big engineering week was a presentation by the University of a panel discussion on the "Employment of Engineers in the Integrated Petroleum Industry."

The moderator for the discussion was Dr. R. W. Karpinski, professor of geology at the Pier who introduced the panel of experts in the petroleum field. Those present were, Dr. J. V. Harrison, former exploration geologist and Oxford professor, now a member of the geology faculty at Urbana; Mrs. K. A. Mygdal, assistant chief, department of exploration and production, Pure Oil Company; Mr. Harry Whitemore, chemical engineer, Universal Oil Products Company; Professor J. C. Chaderton, head of the civil engineering department at UIC, and Mr. Robert F. Baldaste, assistant administrative director, Whiting refinery, Standard Oil Company.

Professor Chaderton led the discussion by outlining the civil engineer's place in petroleum geology with emphasis on research and exploration. Professor Chaderton spent several years in Venezuela working on refinery layouts, pipeline routes and transportation facilities to oilfields.

Mr. Whitemore stressed the opportunities existing in the United States for qualified engineers. He reviewed the procedure of his company with respect to advancement for the young engineer and compared the pay scales of the petroleum industry with those of other firms employing engineers.

Mr. Mygdal and Mr. Baldaste further enlarged on the civil engineer's place in petroleum. Mr. Baldaste invited the engineers present to visit the Whiting refinery in order to gain an insight into the vastness of the industry.

Dr. Harrison presented the economic and political potentialities of oil and the position of the engineer in its production.

The meeting closed with a question and answer period which further emphasized the great number of employment possibilities available in the petroleum industry for engineers of all branches.

Mechanical Engineering at Navy Pier

An efficiently operated department at UIC is that of mechanical engineering. At the Pier, the M. E. department consists of one office, one materials processing lab, one materials costing lab, one welding and allied processes lab and two lecture rooms.

Visitors have been known to comment on the marvelous equipment in the department and the way it is maintained. Few people who enter the UIC branch can say that their observation did not surpass their expectations.

Much of the equipment in the metal processing laboratory is of recent vintage due to the large amount of surplus

Student operating surface grinder

machinery offered after the war. Skillful speculation has equipped our labs with some of the finest machines available at a very low cost to the University. Associate Professor J. S. Kozacka, department head, is responsible for a great deal of the foresight in purchasing this equipment.

The foundry and materials casting laboratory gives the student an opportunity to work on modern equipment of the type being used in industry today. An electric arc furnace with a 300 *lb* capacity is used for melting grey iron and steel. Complete ventilation is provided for fumes and a water jacket keeps the temperature of the furnace and of the room at a minimum. Facilities for hand, squeezer and rollover molding are available for production operation which is assisted by a small sand conveyor system. A sand testing lab with equipment for preparing samples and testing them is available and in operation. This room is also a metal testing lab with several testing devices for determining physical characteristics of prepared metals.

Adjacent to the melting and molding room is a core room which is equipped with several devices for high speed work. Included are a core blowing machine, an automatic oven for baking cores, sand mixers, and a jolt machine.

At the present time, four courses are being offered by the mechanical engineering department. These courses are identical to those at the Urbana-Champaign campus. M. E. 171, a course dealing with the transmission and modification of motion by gears, cams, ropes, chains, etc. is required of all M. E.'s except aeronauticals. Manufacturing Processes, 182, gives aeronautical engineers a general knowledge of fabrication and production operations with special welding training. It also concerns the theory behind the operations which are done in the laboratory as discussed in the lecture rooms. Materials Casting, M. E. 183, concerns casting as a process of fabrication, physical characteristics of metals, and primary metallurgical concepts. Shop practice in molding technique, sand control, core making, melting practice and testing of cast metals is covered in the laboratory. M. E. 184, Metal Processing, concerns the elementary processes in machining used for production work. Lectures are conducted which deal with cutting speeds, machines, and machining processes. Laboratory work combines theory and techniques of metal fabrication.

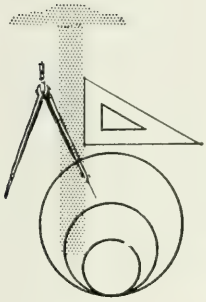
The welding lab, used primarily by aeronautical engineers, has individual booths for arc welding, featuring new welding units. Outlets for torch uses are provided for each of the students in addition to a work table and accessories for each operator. Spot and heliarc welding equipment are in operation in order that specialized and production training may be obtained.

The metal processing lab or machine shop is capable of producing practically any object in small lots or production. Many of the castings which are made in the foundry receive their machining in the laboratory so that students may observe the complete sequence of operations in the production of metal parts. An inspection laboratory, in which students accurately measure their projects and specially designed objects, is used to a high degree. Jigs and fixtures are used, as in industry, for much of the work to produce interchangeable parts.

Mechanical engineering at the Pier, as in other schools, comprises a very large percentage of the students enrolled in the engineering college. Out of the 679 students listed as engineers 198 are in the mechanical curriculum giving rise to a percentage of 29 per cent.

To promote interest and a higher degree of proficiency, the students are assigned projects in the various courses offered at the pier. These projects give

(Continued on page 32)



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NAVY PIER . . .

(continued from page 30)

their an opportunity to apply the knowledge they have gained and also analyze problems to the point where a remedy can be easily obtained. In all of these, personal initiative is strongly encouraged.

The project in Materials Casting, for instance, is a complete layout of a foundry based around the casting desired. The student is given a blueprint of the part to be manufactured and from this he decides the pattern construction, type of molding, type of furnace, plant layout and all related devices or systems pertinent to its manufacture. He is encouraged to write to professional men to receive their ideas on the manufacture of the object.

Much of the time spent in the metal processing lab is devoted to set up of machines as the student sees fit. Here, too, he is allowed to determine in his mind what the most efficient sequence of operation is and has sufficient equipment with which to carry it out. Many of the projects have a practical use and can be purchased by the students if they pay for the materials. This is an added incentive to do good work.

Because of the location of the Pier, in the midst of a great industrial area, jobs for the students during the summer months can be easily obtained. Cooperation of the M. E. department with many of the Chicago firms provides a constant source of employment for men desiring it. During the last summer, it was estimated by Mr. R. W. Schroeder that 15 students obtained jobs through the efforts of the department. This not only provides an income for the student but develops a closer relationship between industry and education which is good to have when a necessity arises for it. Employment upon graduation is influenced greatly by this familiarity.

Prominent among the professional organization at UIC campus is the Student Branch of the American Society of Mechanical Engineers. Sponsored by Professor Kozacka it boasts a membership of over fifty students with many prospective members. Meetings are held approximately twice a month with, if possible, a speaker or film at each gathering. Subjects of a diversified nature usually are in greatest demand by the members and are given to them. Recently, a successful field trip was conducted to the Central Foundry Division of General Motors in Danville and also to the engineering department downstate. Enthusiasm over the trip was exuberant being shown by the amount of students that had to be turned down after reservations were completely filled.

At the head of the department is Associate Professor J. S. Kozacka, who graduated from the University of Michigan with a masters degree. Since graduation he has had experience with General Electric, Packard Motor Car, Chrysler Corporation, Pratt and Whitney, and Vascology-Ramet Corporation, manufacturers of tungsten carbide tools. After working in the field for many years he turned to teaching and supervision of engineering shop laboratories at Lewis Institute and Illinois Institute of Technology. During much of his work he specialized in industrial engineering and research in metal cutting techniques and tungsten carbide bearings.

Roy Schroeder, instructor in materials casting, formerly taught foundry practice at Urbana, Crane Tech. High School in Chicago, and Washburne Trade School in Chicago. Much of his experience in industry was with the Western Electric Co. He is active in the American Foundrymen's Association and the Student Branch of the A S M E at the Pier.

Robert Kennedy, before coming to the Pier, taught downstate where he served in the capacity of assistant professor. His interest lies primarily in foundry work where he has achieved much fame for many of the new methods now used in casting processes. He graduated from the University of Illinois with high honors. At the present time he is Secretary Emeritus of the American Foundrymen's Association and is also active in the Foundry Educational Foundation.

Arnold C. Cobb, instructor in theoretical and applied mechanics graduated from the Pennsylvania State College where he received his B. S. and M. S. in mechanical engineering. He has been employed by the N. Y. C. and St. L. R. R. (Nickel Plate Road) where he served in various capacities, by the American Steel and Wire Co., and the Socony Vacuum Oil Co. He has teaching experience at University of Minnesota, North Dakota Agricultural College and the University of Illinois. He is currently a member of the A S M E and Pi Kappa Alpha Fraternity and a former sponsor of the UIC Student Branch of the A S M E.

Assistant professor of mechanical engineering at the Pier is Roy B. Perkins, who obtained his B. S. at University of Wyoming and his M. S. at Cornell. He has instructed in institutions such as the School of Vocational and Adult Education in Wausau, Wisconsin, Cornell University, and the University of Illinois. He is an active member of American Society for Engineering Education, American Welding Society, and the American Association of University Professors.

OPEN HOUSE . . .

(continued from page 10)

harmonized color with its music.

A variety of movies of processes and fields of engineering were shown, and numerous models and displays were to be seen throughout North campus.

Such was the magnificence of the 1950 Open House. A conservative estimate of the number of guests in attendance was placed at 10,000, a large proportion of whom were high school students. The 1952 Open House promises to surpass all its predecessors in its exhibits and attendance.

Plans for the '52 Open House are well under way, the committees already having been set up. General chairman of the open house this year is Jim Garman, a senior from Bethany, Illinois. An honor student as well as an activity leader, Jim will receive two degrees come June, one in mechanical engineering and one in agricultural engineering. The four committee chairmen are Ed Fort, publicity; Charles Hudson, program; Dan Levin, physical arrangements; and Duane McCurdy, parade. Bob Coughlin is the secretary-treasurer.

The details of this year's Open House are not completely worked out yet, but they will be reported in the coming issues of the *Technograph*. Above all at this moment, we are inviting *you* to the 1952 Engineering Open House. As Dean Enger said in his welcome to the visitors at the '41 Open House, "The students and the faculty of the college of engineering give you a hearty welcome to this exhibition of the facilities of the college. The laboratories will be in operation and various tests and demonstrations will be explained. We hope that you will see as much as possible of the exhibition and carry away a clearer impression of the many activities included under engineering."

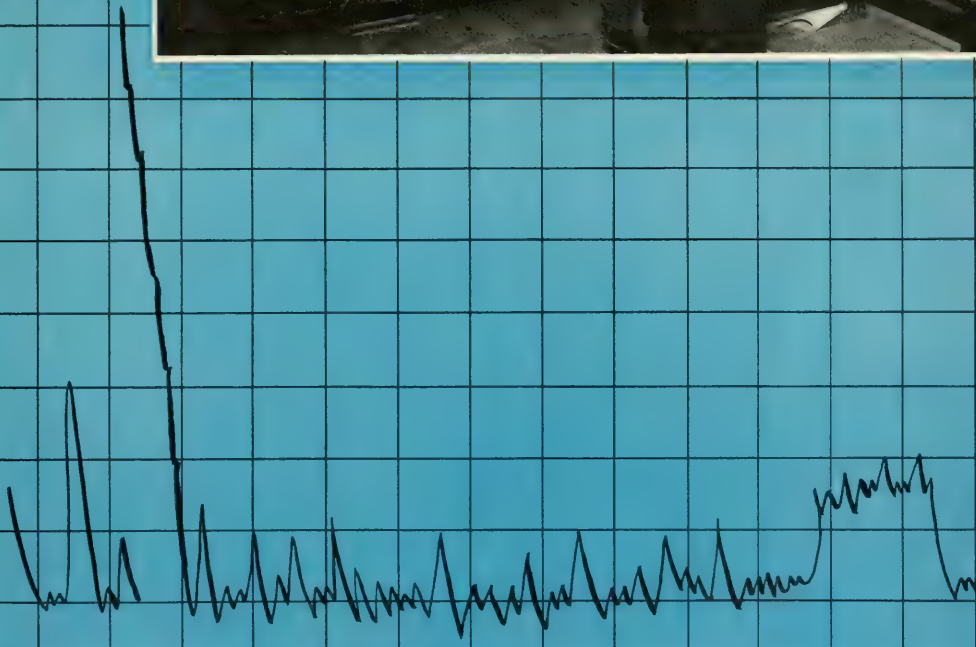
"Touchdown" Saunders, football player for a southern school, was having trouble with his grades. Since he was the star player on the team, his services were needed. He was called into the principal's office for re-examination.

The school head decided to give Saunders a one-question examination. And since he was a Florida boy the question was: "What is the capital of Florida?"

"Touchdown" sweated over this for some time and finally wrote Monticello on his test paper.

He passed. In checking the answer the principal said 100 was perfect and Monticello is twenty-five miles from Tallahassee. Twenty-five from 100 leaves seventy-five. And seventy-five is passing.

25¢



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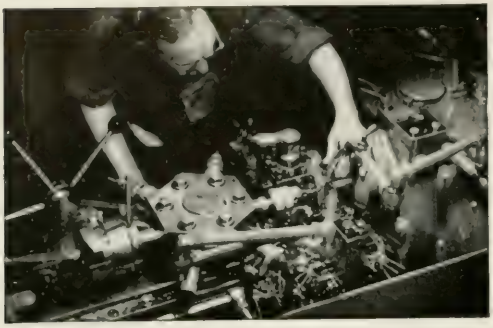
Another page for **YOUR BEARING NOTEBOOK**

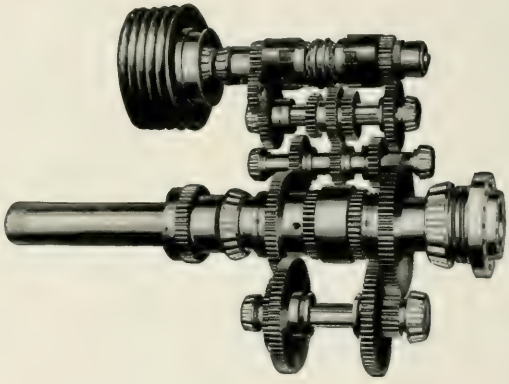


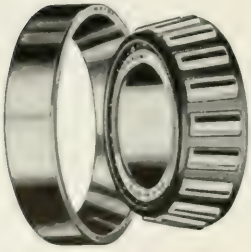
For high-precision gear trains TIMKEN® bearings are just the ticket

Shaft deflection or end-movement in a lathe gear train causes inaccurate meshing of gears, excess wear and loss of precision. So to insure shaft rigidity, leading machine tool designers specify Timken® precision bearings for spindles and other shafts. Due to their tapered construction, Timken tapered roller bearings carry thrust and radial loads in any combination. Shafts are held in proper alignment. Accurate meshing of gears is assured.

How to mount tapered roller bearings in a lathe head

The two single-row Timken precision bearings on the spindle are mounted indirectly. On the spindle end, the cones are pressed to the spindle shoulder. The bearing on the opposite end is backed by a collar, gear and nut. A two-row, indirectly mounted bearing is used on the pulley end of the input shaft. The remaining Timken bearings are directly mounted, and shim-adjusted.





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the illinois technograph

volume 67 number 5

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our cover

Prof. Ralph E. Meagher examines an answer printed on its teletypewriter input-output unit by the new "electronic brain" just completed at the University of Illinois. In the cabinet beyond is the "brain" itself. In the enclosed upper section is its memory unit, in the lower part the arthimetic, and the control units. (See page 7)

our frontispiece

A new GE jet engine, the J-47-GE-21, is prepared for the test cell at the GE Lockland, Ohio, plant. The new engine, the first of the Advanced J-47 series, is the same size as the present jets but is far more powerful than current J-47 engines. Accessories, which are housed in the nose of present models, have been placed underneath to provide a greater air inlet area to the compressor. (Courtesy of General Electric)

one student who passed his final exams . . .

ORDVAC

from A. R. Wildhagen

The "electronic brain" which the University of Illinois has been building since 1949 has passed its "final exams."

Its memory capacity is twice as great as that of any other similar high-speed computer with cathode ray memory tubes now operating.

It can store away 1,024 numbers, and recall any one in 36-millionths of a second.

It can do 10,000 additions a second.

In one thousandth of a second it can multiply a pair of numbers like 549,755,813,887 times 549,755,813,887—which is 12 digits in the decimal system but 39 in the binary system which the machine itself uses.

It has an almost-human ability to follow a complicated series of instructions, carrying on one mathematical operation after another, remembering results, and deciding, sometimes from the answers to calculations just made, what to do next.

In five hours it can do calculations that would take 50 years—a working lifetime—for a man with an ordinary electric "adding machine" type calculator.

In two weeks it can solve a problem which would take a human more than a thousand years.

It has 2,720 vacuum tubes. Forty of these are its memory. Also in the machine are 300 little *½-in* neon tubes and a complicated mass of wiring and electrical parts. All this is in a cabinet 10 *ft* long, 2 *ft* wide, 8½ *ft* tall.

The cathode-ray memory tubes are similar to television picture tubes, but only three inches in diameter. The "memory" appears as glowing green dots on the face of the tube, the 1,024 digits arranged in a square 32 dots high and 32 dots wide.

The memory stores away not only numbers, but also directions of what to do. When the machine operates the dots brighten or dim, and the little neon tubes light, flicker, or darken as calculations go on.

The machine now operating at Illinois will "graduate" from the University in February and join the Army. It is scheduled to be used at the Ballistics Research Laboratories, Aberdeen Proving Ground, Md. A twin machine, now being built, will be completed in June and will remain on the campus.

The "electronic brain" remaining at Illinois will be used for involved mathematical problems and studies in fields ranging from engineering to sociology. The Army machine will be used for preparing gunfire tables and for other complicated mathematics which arise in the government's various scientific laboratories.

Under the contract with the Ordnance Corps of the Army, the University built parts for the two machines at the same time, cutting the cost for both organizations. This contract gives the machine its name of "ORDVAC" from the words "Ordnance Variable Automatic Computer."

The machine now is being tried on the sort of lifetime jobs it and its twin were planned for. A team of Army scientific experts from Aberdeen has come to Illinois with a pack of problems from the Proving Ground. For eight hours a day it works at them. During another eight hours every day the University's scientists and mathematicians are using it.

On many problems the ORDVAC with its electronic memory tubes is 100 times faster than some computing machines which use magnetic drums as memory elements, and 5 times faster than machines which use mercury memory storage elements.

Both those types of machines now are being made commercially. No commercial organization has completed a ma-

(continued on page 32)

Prof. Ralph E. Meagher holds one of the memory tubes of the new "electronic brain" just completed at the University of Illinois.

the technograph tours the . . .

1952 Engineering Open House

by Bob Schrader, ch.e. '54, and John Schultz, cer.e. '52

Every dog will have his day, but campus engineers will have a whole weekend in which to strut their stuff. We are referring, of course, to the all-engineering Open House weekend of March 14.

Festivities will officially begin at 12:00 noon on Friday, March 14, when all student engineers will be excused from classes for the rest of that day and Saturday. The tribute to St. Pat will be inaugurated with a parade, which will begin at 1:30 on Mathews Street and wend its way throughout North Campus. Heading the parade will be the float of St. Pat himself, while his disciples trail him in floats of their own design. Each engineering society will furnish a float, as will the honorary engineering fraternities and two social engineering fraternities, Sigma Phi Delta and Triangle.

After the passage of the parade, the more serious and fundamental aspect of the Open House will begin. Continuous tours through the engineers' domain will take place between 2:00 and 10:00 p. m., on Friday from 9:00 a. m., until 6:00 p. m., Saturday. During this time, the multitude will be able to view engineering careers in action, in the form of displays, exhibits, and lectures.

Talbot Laboratory

The tour will begin at Talbot Laboratory, where exhibits will be presented by the students and faculty of the departments of Theoretical and Applied Mechanics and Civil Engineering. A favorite exhibit here is the impressive demonstration of testing the compressive strength of a large concrete cylinder on the 3,000,000 *lb* hydraulic testing machine. A cylinder will be broken every hour on the half-hour.

Other exhibits of strength determinations in action will include the testing of structural joints on the 200,000 *lb* repeated load machine; the fatigue of metals when repeatedly loaded to failure in bending, torsion, direct stress, and combined stress; the plastic flow of steel beams when subjected to dead loads; and the failure of railroad rails under load.

A movie will be shown demonstrating experimental work in theoretical and applied mechanics. Vibration-measuring instruments will be displayed, along with models of free vibration systems, self-induced vibration systems, forced vibration systems, and the gyroscope. A photoelastic demonstration will show models which glow in bright colors at points of stress when viewed under polarized light.

BOB SCHRADER

A native of Tuscola, Illinois, Bob attended Tuscola High before entering Illinois.

Bob is a junior in chemical engineering, and is a member of Phi Eta Sigma. He has been a diligent writer for the TECH for three semesters; and is an active member of Engineering Council, currently serving as corresponding secretary.

Bob has no special plans for the future beyond staying in ROTC until he is called to service, preferably not until he has received his degree.

JOHN SCHULTZ

John comes to the U. of I. by way of Morton High School and Morton Junior College. He is a senior in ceramic engineering from Cicero, Illinois.

John served as corresponding secretary for the Engineering Council during the past semester, and is also editor-in-chief of the ILLINI CERAMIST, the ceramic engineering yearbook. In addition to his many activities John has been selected for Keramos, Sigma Tau, and Tau Beta Pi.

Static exhibits will include studies of beams and columns, class experiments in hydraulics and fluid mechanics, experiments of testing of materials, exhibitions of plastics and laminations, and soil determinations and equipment. In the lead testing laboratory, long time studies of lead cable used for electric transmission under controlled conditions will be available for scrutiny.

Foundry Laboratory

From Talbot Lab. the route will lead to the Foundry Laboratory. Here, the making of sand molds, casting of cast iron, aluminum, and brass will be demonstrated. Souvenirs will be distributed by the "foundrymen." Other exhibits will include core making and drying, sandblasting, and testing of various properties of molding sands.

Aeronautical Laboratory B.

Aeronautical Laboratory B is next on the agenda. The University Glider Club will display the L. K. glider, which they use in their activities. The Institute of Aeronautical Sciences will exhibit some unusual aircraft engines. Among these will be the pulse jet, largest ever built; the TG-100, first turboprop ever built and tested; a two cylinder engine with counter-rotating props, which is being developed for possible use in lightweight planes of the future; the Walther rocket, an early rocket developed by the Germans; and a German JATO rocket.

Testing devices used by the "aeros" will be on display. Among these are the landing gear drop test, static bend test, and the Wagner tension bend test. Aircraft structures, and student-built aircraft models will be shown; and a shock tube, used to obtain very high velocities for supersonic research, will be demonstrated.

Transportation Building

Upon leaving the Aero Lab, sightseers will "follow the arrows" to the Transportation Building, which will house exhibits by the students in general engineering drawing classes. On display will be 19 patent drawings which have changed civilization, 50 different types of slide-rules, drafting equipment, and industrial production illustrations.

Methods of reproducing engineering drawing will be demonstrated, and a demonstration of the use of black light in teaching engineering drawing will be held. Souvenirs will be given to the visitors.

Mining Laboratory

The Mineral Industries Society will present their exhibits in the Mining Laboratory. Displays of coal and its products, mining equipment, and important minerals will be shown. How photoelasticity is applied to determine stresses around mine openings will be explained. Mine ventilation apparatus, gas analysis, coal preparation, and the oil froth flotation method of separating minerals will be demonstrated. There will also be demonstrations of the explosibility of coal dust and the use of a mine safety lamp for the detection of gas. A model of a mine will be shown, and movies of mining and metallurgical operations will be run continuously.

Metallurgical Laboratory

The Metallurgical Lab will offer some mystifying exhibitions. These "Mandrakes of the metals" will make steel *shrink* upon heating, make metal cry out loud, and turn cold metal hot while in the on-looker's hand. Visitors will also be able to see the structure of metals through a microscope, steel magnified 1,000 times, steel hardened by heat treatment, invisible cracks in metal parts by magnetic inspection, and watch metal run like water. Movies will be shown disclosing metal production, forming, and heat treatment. Good luck pieces will be nickel-plated while the visitor watches and given as souvenirs.

Aeronautical Laboratory A.

In Aeronautical Laboratory A, the Institute of Aeronautical Sciences will demonstrate the lifting forces on a typical airfoil in the University wind tunnel.

Ceramics Building

The members of the Student Branch of the American Ceramic Society will demonstrate their art in the Ceramics Building. Among the demonstrations will be the spraying and firing of porcelain enamels, smelting of enamels in a rotary smelter, slip casting of pottery ware, and jiggering and throwing of pottery and dinnerware. The brick machine will be on display, and elements of microscopy and pyrometry will be explained.

Static exhibits will include flow diagrams indicating raw materials and manufacturing processes used in the ceramic industry, and displays of pottery, glass, dinnerware, enameled ware, refractories, cements, structural clay products, abrasives, and enameled jet engine parts.

Mechanical Engineering Building

All of the major fields of mechanical engineering will be represented in the ME building, the next stop on the route. The design laboratories will present displays of tools, as well as a demonstration of the photoelastic stresses in gear teeth and the fatigue of metals as seen under a microscope. Gas welding and cutting, arc welding, and metal

spraying will also be shown. The machine tool lab will have a display of machine tools and demonstrations of machining parts for small engines.

The field of heat treatment is represented by demonstrations showing the heating steel by induction, the heating and quenching of steel, and the determination of the temperature of a match flame. A cutaway automotive chassis showing the moving parts is the feature of the internal combustion laboratory. Also included are gasoline and diesel test engines with variable compression ratios, and a setup for a small aircraft engine stimulating high altitude conditions. Other ME labs cover the subject of fluids with several demstrations.

Across the street in the ME laboratory the main floor is covered with interesting exhibits. They include a unit power plant, a cutaway of an aircraft jet engine, air conditioning test apparatus, and a motorist reaction timer in which every motorist can test his reaction time.

Chemical Engineering Building

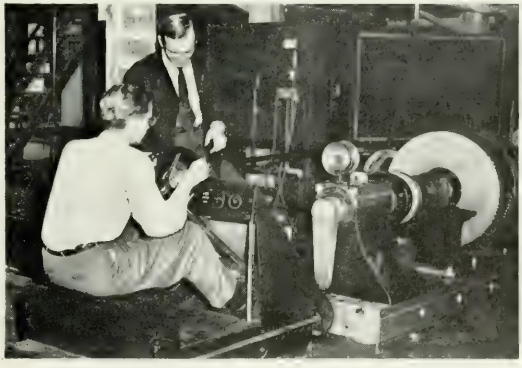
Two blocks down the street is the Chemical Engineering building. The Chem E exhibit is featured by a tour through the famous Unit Operations Lab. This lab has excellent facilities for the study of the six fundamental operations of chemical engineering: distillation, extraction, filtration, heat transfer, absorption, and evaporation. This huge lab has a floor to ceiling distance of *36 ft.*

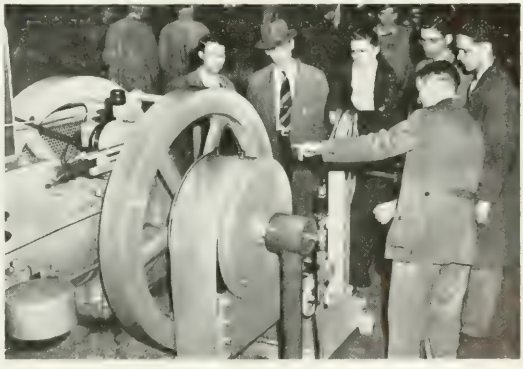
Other exhibits include a continuous rotary filter in operation and an actual distillation in an all-glass distillation unit. Another popular spot in the Chem E building will be the Aqua Hacienda featuring free hydrogen hydroxide cocktails.

Physics Laboratory

Still following the arrows, the Physics Laboratory is next on the route. The Physics department will present demonstrations of phenomena based on fundamental physical principles. Topics touched on will include liquid air, standing waves, and gravitation and accelera-

(continued on page 18)





Left: An ASE guide shows a visitor how to operate the mechanism of the driver's reaction testing device.
Right: A horsepower producer of a bygone era attracts attention in the Mechanical Engineering Lab.

U. S. Geographical Surveys

by Warren H. Brandt, c.e. '54

Introduction

Modern surveys of extensive areas are executed in such a manner that a minimum amount of field work is required. Topography, the assembling of data relative to the configuration of the earth's surface, location of buildings, bridges, etc., can be secured to a high degree of precision by aerial photography with a limited number of ground survey control points. It is estimated that an area that could be mapped with the use of aerial photographs in 90 days would require two years of field work by ground methods to produce a map of comparable accuracy.

WARREN H. BRANDT

Warren graduated from Lane Technical School in 1942. Since then, he has worked with surveying parties of the Chicago and Northwestern Railway and in railroad and highway design with De Leuw, Cather and Co., prominent Chicago consulting engineers.

He is a member of ASCE, SAME, and the Western Society of Engineers.

His article of "Geodetic Control Surveys in the Chicago Area" appeared in the November, 1950, issue of the TECHNOGRAPH.

As with almost every branch of science, great strides have been made within the last 50 years in the art of surveying and topographic mapping. The stories of the arduous tasks of long treks up hill and down valley have just about faded into antiquity. To appreciate our present position, however, it compels one interested in the subject to examine the work initiating topographic mapping in this country. The work of the first organized agency for the securing of data to compile a topographic map will be the subject of this article.

Location

The area west of the one hundredth meridian, that is a line running north and south, roughly through the center of the Dakotas, Nebraska, Kansas and Texas, embraces 1,443,360 square miles in seventeen states. Of this area, 993,360 square miles are mountainous.

Following the Civil War the War Department became conscious of the lack of accurate data concerning this vast region. The need for maps was particularly great and the Chief of Engineers in 1869, was instructed to commence a survey to secure the necessary information, primarily for military purposes.

To take charge of this work the Chief selected a young engineer, Lieutenant George Montague Wheeler, 27, three years out of West Point. Wheeler had been employed on surveying duty with the commanding general's staff, Department of California. Out of funds provided from general appropriations to the Chief of Engineers, Wheeler was able to execute surveys of a limited extent in 1869. Traversed were 24,028 square miles in southeastern Nevada and four hundred square miles in Utah.

Formal Organization

In 1871 the "United States Geographical Surveys West of the One Hundredth Meridian" was set up as a separate entity under the Chief of Engineers. Official action on the Surveys by the Congress was secured by an act approved June 10, 1872. Appropriations for the Survey were thereafter assured.

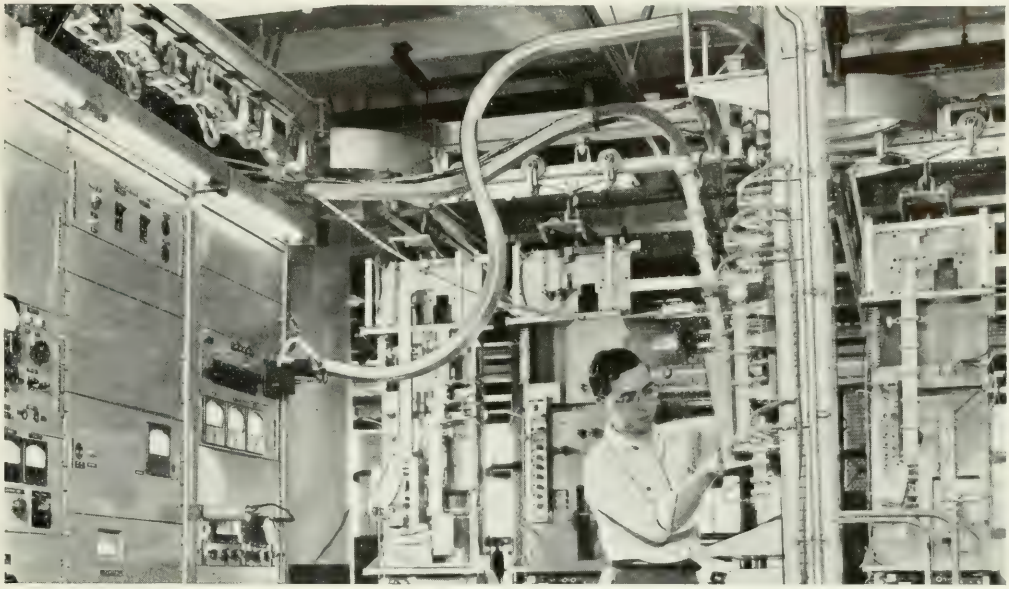
The full extent of the investigation was enlarged at this time to include much work outside the field of topographic mapping. The requirements of the Chief of Engineers are stated in a letter to Wheeler given below:

"Office of the Chief of Engineers
Washington, D. C., March 23, 1871
SIR: The Secretary of War, in his his orders of March 18, 1871, *a copy of*

(*continued on page* 24)

Wheeler survey party camped at crossing of the Colorado River below the mouth of the Grand Canyon, October 6, 1871.

Where engineering and pioneering go together!



The transmitter-receiver bay unit being worked on by a Western Electric tester, is part of the complex equipment installed in the Bell System's coast-to-coast microwave relay towers. Special testing equipment is at the left.

Operator inspects a grid blank. The grid controls the flow of power through the tiny electron tube which is the heart of radio relay. Western Electric engineers designed machines to wind wire .0003 inch in diameter on the grid at 1000 turns per inch—spaced exactly .0007 inch apart.

COMPLETION last Fall of the Bell Telephone System's coast-to-coast radio relay route climaxed a production feat that involved doing many things never done before.

The engineers at Western Electric—manufacturing unit of the Bell System—were treading on uncharted ground when they tackled the challenging job of making the highly complex equipment.

This radio relay equipment—which transmits telephone and television signals at a carrier frequency of four thousand megacycles per second—called for many components never made before and for which no machinery, no tools, no assembly processes were known. Some components required almost unbelievably tiny parts—and fantastically small tolerances.

Manufacturing facilities and techniques had to be developed to assemble and wire the complicated equipment which receives signals having less than 1/10 millionth of the power of an ordinary flashlight bulb—at frequencies ten times as high as those used in television sets—amplifies these signals 10 millionfold and transmits them to the next tower some 30 miles away.

Finally, Western's engineers were responsible for installing the equipment in 107 towers across the nation.

In all phases of this job, engineers of varied skills worked closely together as a team which just wouldn't be stopped merely because "it hadn't been done before." That's typical of work at Western Electric—where engineering and pioneering go together.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

by Bob Schrader, ch.e. '54

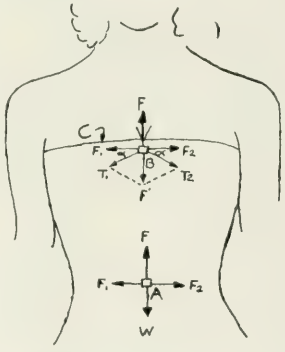
Have you ever wondered what those words *Member ECMA* on the cover of the *Tech* stand for? Well, gather round readers, you're going to be educated about the facts of life. ECMA, or Engineering College Magazines Associated is a group of thirty-six college magazines to which the Technograph belongs. To let you get acquainted with some other ECMA magazines, this months *Byline* will print digests of a few of their articles.

A thought provoking paragraph on "What is Engineering?" from the Southern Cal Engineer starts off the parade.

Engineering is essentially a problem-solving occupation. That fact colors the thinking of every engineer. For the research engineer, the problems are to discover and apply natural law. The design engineer solves problems in the economic use of materials. The engineer in plant operation solves problems of quality control, obsolescence, raw-material supply, and trouble-shooting of all kinds. The construction engineer faces complex problems in logistics and in adapting plans and specifications to the unforseen exigencies of the field. Engineers solve all these problems by rigorous calculation, by past experience, or by plain common sense. But the main point is, the engineer's life is one long series of problems to be solved, and his success depends on promptly delivering good workable answers. This problem-solving attitude is perhaps the most characteristic feature of engineers as a group.

* * *

The California Engineer printed an informative article on the structural analysis of a strapless evening gown. This analysis is diagrammed in Fig. 1. A small elemental strip of cloth A, located near the middle of the dress, is isolated as a free body. F_1, the tangential force on A, is balanced by an equal and opposite force, F_2. The downward force W caused by the weight of the dress below A is balanced by the force F acting vertically upward due to the stress in the cloth above A. Therefore, since the algebraic summation of the horizontal and vertical forces is zero, and no moments are acting, the elemental strip is in equilibrium.



An entirely different situation results if an elemental strip near the top of the dress in considered. Consider strip B for example. The two tangential forces F_1 and F_2 are equal and opposite as before, but the force W due to the weight of the dress below B is not balanced by an upward force, since there is no cloth above B to supply this force. Therefore, the strip is not in equilibrium.

But it is imperative, for social reasons, that the extra force required for equilibrium must be supplied. Friction can be used to supply this force. The frictional force can be expressed as $F=fN$, where F is the frictional force, f is the coefficient of friction, and N the normal force. To increase F, the normal force must be increased. This can be done by making the diameter of the dress at line C smaller than the diameter of the female at this point. Most of the vertical force F, however, will have to be supplied by the female herself, using her own natural endowments. This method of support is up to the female alone. Science can do no more.

* * *

The Auburn Engineer had a fine article on opportunities in Atomic energy for graduates from *all* fields of engineering. Fine opportunities for ME's and CE's in plant design and construction are present. Sanitary engineers are needed to solve the very difficult problem of radioactive waste disposal. There are many openings for EE's and engineering physicists, especially those men with a talent for electronic instrument design. Jobs in the field of nuclear-propelled aircraft are available to aeronautical engineers who are well-grounded in the theoretical phases of aerodynamics and fluid mechanics.

The general public hears much about the need for nuclear engineers. Although nuclear engineers as such are not trained in colleges, chemical engineers with a strong background in physics, heat transfer, mass transfer, and chemical thermodynamics are well-trained for this type of work.

* * *

Another article from the California Engineer raises the old argument of steam power versus gasoline power for automobiles.

A steam car needs no transmission. It is directly coupled to the differential. It can go up the steepest hill or at the slowest speed without jerking. Steam can be admitted to the engine in any quantity desired. The vehicle can slowly glide away from a stop with absolutely no noise or vibration. This is the goal for which present-day automobile makers are striving. No automatic transmission can match the steamer's low-speed power. And no gasoline car can

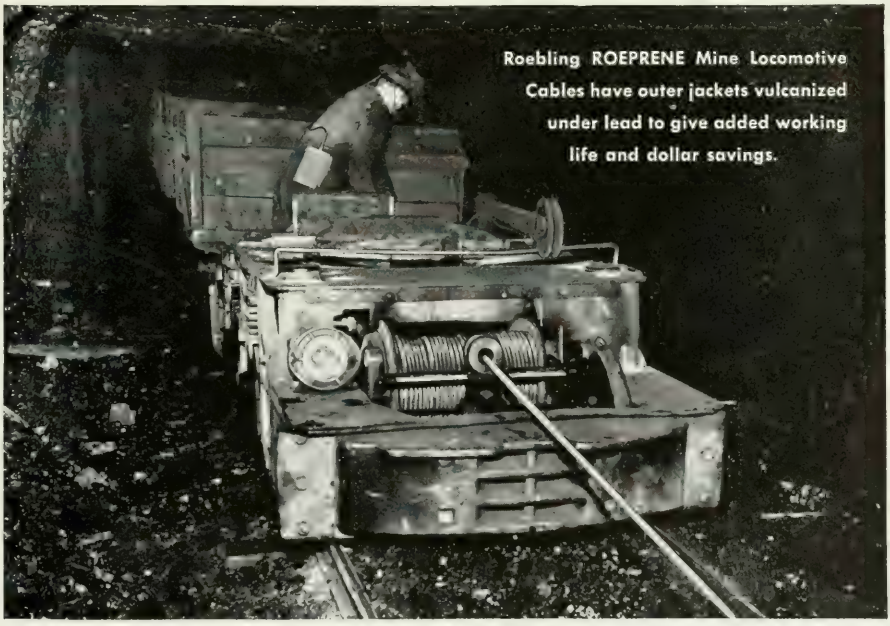
(*continued on page* 18)

ELECTRICAL WIRE AND CABLE

The complete Roebling line meets every transmission, distribution and service need

ROEBLING is the best-known name in the whole field of wire and wire products . . . and from their copper conductors to their protective jackets, Roebling electrical wires and cables are produced entirely in Roebling plants. There's a complete line, too . . . more than sixty standard types representing the best that is known today in materials and construction . . . assuring maximum dependability and utmost economy on the job.

And here's another important fact: many Roebling electrical wires and cables afford *special* advantages to users. One type of cable, for example, brings substantial savings in installation costs. Another type, due to extras built into it, lasts longer and saves replacement dollars . . . Outstanding today, the staff of Roebling's research laboratory works continually to assure even better products tomorrow. John A. Roebling's Sons Company, Trenton 2, New Jersey.



Roebling ROEPRENE Mine Locomotive Cables have outer jackets vulcanized under lead to give added working life and dollar savings.

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skimming industrial headlines

edited by Howie Hadler, ag.e. '54

s. s. united states nears completion

The S. S. United States, largest and fastest passenger ship ever built in this country, is now about 85 per cent completed, it was announced recently by the United States Lines, New York, N. Y. The $70,000,000 ship was christened at Newport News last June and is now at her outfitting dock in the Newport News Shipbuilding and Dry Dock Company yards. Her maiden voyage is scheduled for the early summer of 1952. Westinghouse propulsion equipment will drive the 990 ft ship at a speed in excess of 30 knots.

The peacetime capacity of the liner will be 2,000 passengers with a crew of 1,000, although in an emergency she could be converted into a troop ship capable of carrying an entire division of 14,000 men 10,000 miles without stops for fuel, water, or food.

More than 2,500 workmen are now engaged in the final stages of construction prior to the arrival of the interior decorators.

Bulkheads, electrical equipment, complex systems of pipes and ducts for fresh water, salt water, steam, and ventilation are going into place. Prefabricated shower enclosures, for quick and easy installation, are going into passenger spaces. Galley equipment, including ranges, ovens, peelers, shredders, griddles, batch mixers, and dish washing machines, is being snugged into place.

According to the United States Lines, work on board will continue right on through the cold weather. As the weather becomes cold, steam from the shipyard's own plant will be piped aboard to provide comfort for the working crew as well as to expedite the drying of the many thousands of gallons of fire-retardant paint that will be used.

The S. S. United States being outfitted at her docks at Newport News. (Courtesy of Westinghouse)

new raw materials for plastics and coatings industries

Announcement was made recently of a new family of compounds which is expected to become a versatile series of raw materials for the plastics and coatings industries. Termed "resinous alcohols," the compounds are formed by the reaction of glycerine, rosin, and fatty acids. The products are neutral mixtures of mono-, di-, and tri-glyceride esters, with monoglycerides predominating. The liquids have all the characteristics of resins—luster, molasses-like consistency at room temperature, and amorphous structure. In addition, glycerine, an alcohol itself, contributes free, highly reactive hydroxyl groups from which resinous alcohols derive their name as well as a great part of their potential usefulness. Free hydroxyl groups serve as chemical hooks which can attach themselves to other compounds. They make it possible for resinous alcohols to combine, for instance, with vegetable oils to form fast-drying, tough and durable varnishes, and phtallic or maleic anhydride to form hard alkyd resins of many uses. Free hydroxyl groups are also responsible for the solubility of resinous alcohols in many of the solvents used in lacquer and varnish manufacture.

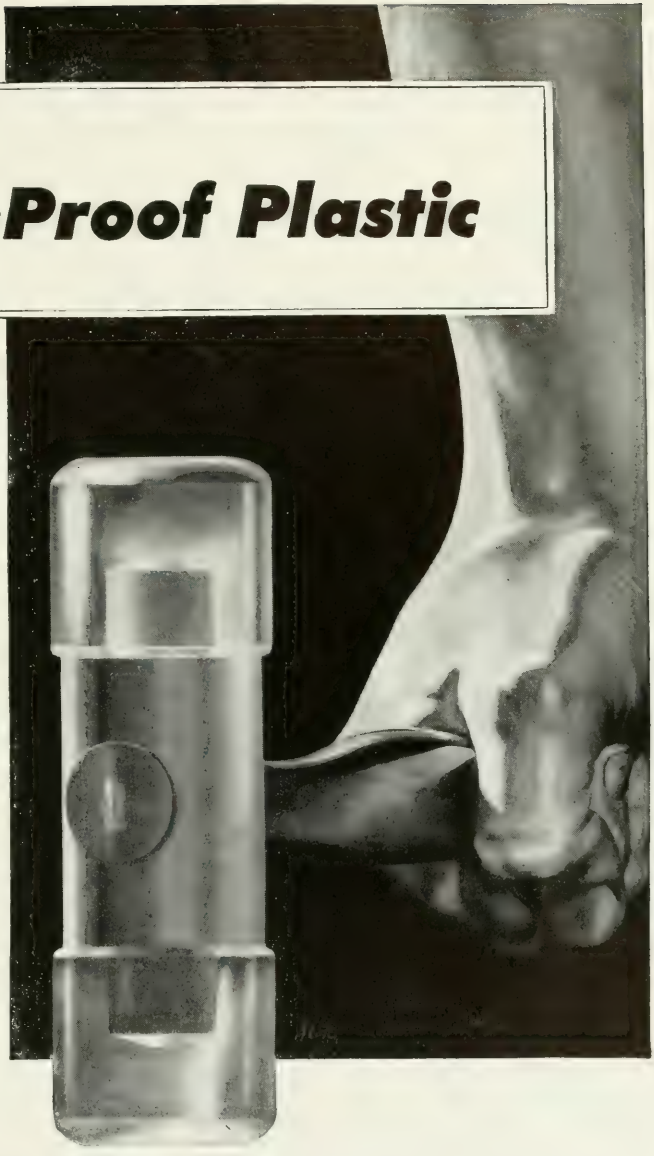
wood offered for steel substitute in construction

The lumber industry and Washington planners are offering fabricated lumber as a practical alternate for structural steel.

The idea was used during World War II, but recent developments in the manufacture of plywood and in chemical treating of wood give it greater toughness and heat resistance, making it practical as a steel substitute in a wide variety of construction.

(continued on page 22)

Pound-Proof Plastic



CHEMICAL PROBLEM . . .

. . . to provide a tough material for the heads of "soft-face" hammers used to form sheet metal in such work as the fabrication of airplane sections.

SOLUTION . . .

. . . Hercules® Ethyl Cellulose . . . an extremely tough and durable plastic widely used for tool parts and other industrial needs. No other low-cost plastic can match its impact strength and resistance to distortion from humidity and temperature extremes. "Ethyl" now plays a major role in many key defense and civilian products.

COLLEGE MEN . . .

This is but one example of the far-reaching chemical developments in which you could participate at Hercules—in research, production, sales, or staff operations. It suggests the ways Hercules' products serve an ever-broadening range of industries and end-uses.

Hercules' business is solving problems by chemistry for industry . . .

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introducing . . .

by Mel Rudich, gen.e. '53, Bob Schrader, ch.e. '54, and Tom Madden, m.e. '54

GEORGE RATKOVIC

After every presidential election, newspapers and magazines all over the nation are full of accounts about our new commander-in-chief. Since this is true, it is only fitting that the engineering magazine on campus should present a short history of the president of the Engineering Council newly elected in January. The new Council president is George Ratkovic.

George is a native of Cicero, graduating from Morton High School. After

GEORGE RATKOVIC

graduation, he spent two years at Morton Junior College before coming to Illinois. A senior in chemical engineering, George is now in his third semester on the Council as AIChE representative. Last semester George was elected vice-president of the council.

In addition to his council duties, George has been active elsewhere on campus. He is the engineering college's representative to the career conference committee, and has charge of procuring the speakers on engineering for the conference. Last year he was on the St. Pat's Ball committee, and this year he is in charge of an AIChE district conclave to be at the U. of I. in March. George has done all this in addition to maintaining a satisfactory record in the Chem E. Curriculum. He is a member of Triangle Fraternity.

George is an ardent sports fan. He lettered in boxing at Morton High School. This year he made up one-half of a doubles team which reached the semifinals of the University Intramural tennis tournament. George also likes to bowl and play golf, and is an ardent White Sox supporter. He suffered a thousand deaths with them in the '51 pennant race.

Most of George's spare time is taken up by a certain Miss Nancy Vesely, who was Triangle's queen candidate for the Star and Scroll Formal last fall. George will graduate in February of 1953. Although his future is in the hands of Uncle Sam, his success is assured if he continues to do as excellent a job as he has done here at Illinois.

PROF. PAUL K. HUDSON

Professor Hudson, Assistant Professor of Electrical Engineering here at the University of Illinois since 1947, last fall assumed the job as one of the faculty advisors of the *TECH*.

Born in Athens, Ohio, he received the B.S. and M.S. degrees in EE from Ohio University. Upon graduation from college he was employed as foreman at the standardizing laboratory of the Ohio Power Company for several years. Following his work in Ohio, Mr. Hudson served in the capacities of instructor in EE at the University of Arkansas and associate professor of EE at the University of Idaho. While at Idaho he was faculty advisor for the *Idaho Engineer*. With the advent of World War II he was called east to take the position of Training Engineer for Columbia University under the Division of War Research. His duties were mainly at New London, Connecticut, where submarine warfare work was being conducted at the United States Navy Underwater Sound Laboratory.

Upon completion of his wartime job for Columbia University, Paul Hudson came to the University of Illinois as an assistant professor of electrical engineering. Even though he is a full time instructor, Professor Hudson does much research work on his own time, his special interests lying mainly in electromedical applications and research. He has his own philosophical ideas on student instruction and believes that "a college program is in balance when the teachers contribute 90 per cent and the physical plant contributes 10 per cent to the overall progress of the student. A good teacher is one who is interested in the welfare of the students in the same sense that he is interested in the welfare of his children."

Married, and the father of a two-month old baby girl, Paul Hudson has other hobbies and interests outside of the electrical engineering field. His hobbies include ceramic arts and garden-

PROF. PAUL K. HUDSON

ing. As for civic interests, he is an active member of the Urbana Association of Commerce and a member of Knights Templar.

We, the members of the *TECH* Staff, wish to extend a belated, but hearty welcome to Professor Hudson as our new faculty advisor.

JOHN UNDERWOOD

Many of the students here at Illinois are familiar with the fine cheerleading of John Underwood '52, at the football and basketball games. However, few of them realize that Illini's head cheerleader is also a senior in engineering.

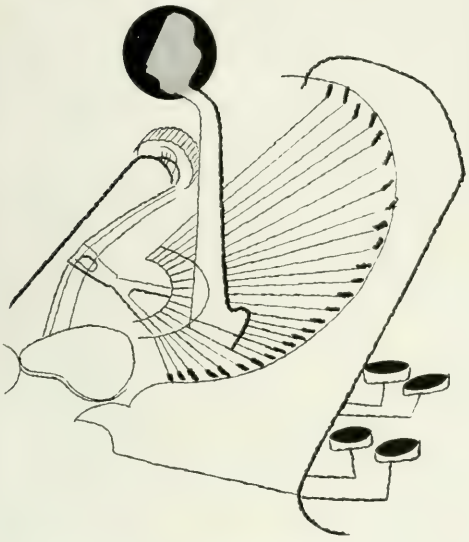
John, who lives in Herrin, Illinois, graduated from high school in June, 1947, and then entered the Army, where he served 18 months as a Cadre Instructor with the rank of sergeant in the Armored Division. Upon discharge in December of 1948, John entered Southern Illinois University where he pursued his freshman engineering curriculum.

In his sophomore year he transferred to Illinois, where, for the past two and one-half years, he has been active in various campus activities such as the construction of the first place Illuminating Society's engineering exhibit in the 1950 I SEE Open House. He was recently appointed chairman of the IES

(*continued on page 32*)

What's Happening at CRUCIBLE

about special shape type steel



5. The flash trimmed off after the swadging operation.

6. The finished type ready for hardening, plating and soldering to the type bar.

The production of Crucible steel for this job is the result of engineering and practical know-how combined with a special method of manufacture to assure a homogeneous microstructure for maximum forming properties, excellent surface characteristics for good die life, and close accuracy control for all dimensions of the shape.

The production of type steel requires the use of small precision rolling mills equipped with shaped rolls and operated by skilled workmen. During preliminary and final inspection, shadowgraph equipment is constantly used to check for size accuracy.

As a result of its outstanding quality, Crucible's special shape type steel is constantly in demand and used by leading typewriter manufacturers.

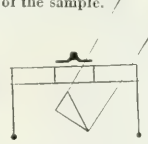
Crucible special purpose steel for type character application

The development of cold rolled special shape type steel is one of Crucible's important contributions to the business machine industry. A major part of the type characters used for the manufacture of typewriters are made from this special shape.

Shadowgraph Operation:

Since micrometer measurements are impractical due to the shape, the shadowgraph is used to measure shape and size . . . minimum and maximum tolerances. The shadowgraph is a projection, greatly magnified . . . on a calibrated screen . . . of the sample.

Schematic of shadowgraph



Here's the step-by-step process:

1. Cold rolled special shape produced by Crucible.

2. The type slug cut from the special shape material.

3. The wings of the type slug are bent down and taper formed toward the edges.

4. The type characters are cold swadged on the solid edge of the bent type slug.

If you have a requirement for special steels—check with Crucible. Feel free to draw on the experience of our metallurgists and engineers. Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

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National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

OPEN HOUSE . . .

(continued from page 17)

tion. Polarized light, microwaves, the gyroscope, cosmic rays, and the physics of music are the subjects of other demonstrations. The Physics show will conclude with a conducted tour through the cyclotron building.

Civil Engineering Hall

Both civil and sanitary engineering will have their displays in CE hall. The civil engineers will present a model construction site, silhouette structures showing various types of trusses, and displays of surveying equipment and hydrologic instruments. The exhibit ends with several movies and a display of design problems in all phases of civil engineering.

The sanitary engineers will explain proper septic tank construction, proper well construction, and the proper methods of sanitary land filling. The sanitary engineering show also contains several movies, a sample of student work, and a diorama telling the story of sewage disposal from 1800 to 1950.

EE Building

The final stop on the engineering campus will be the Electrical Engineering building, where power, communications, electronics, and illumination are all represented. Radar and the lighting of bulbs with no electrical connection are featured in the ultra high frequency lab. In the electronics lab, sightseers can write with a stream of electrons, have music at the wave of their hand, and test their powers of osculation at the kissometer.

The section on light includes demonstrations on black light, color, the shadow effect, and the stroboscopic effect, in which drops of water are seemingly stopped in mid-air. The power lab contains many interesting and amusing experiments on motors.

After leaving the EE building, Open House visitors can catch buses which will take them to the Ag Engineering Building, the Armory, Abbott Power plant, and the Betatron Building.

Ag Engineering Building

Ag Engineering consists of two options, the MF and CE. The MF option exhibits will feature a comparison of liquified petroleum gas and gasoline as tractor fuels, a display of lifting heavy machinery by hydraulic controls, and an example of research work on tractor valves. The CE option will present scale working models of farm building and crop storage structures, a demonstration on the use of good tile, and a unit on modern farming through use of supplementary irrigation.

The Armory will contain an interesting and varied exhibit of the many training aids used by the different branches of the Army and Air Force units. Abbott power plant, another stop on the bus route, is the power plant for the U. of I. The final stop on this tour is the Betatron Building. The betatron is a device for accelerating electrons to amazingly high speeds so that they may be used to split the nuclei of atoms. This 300,000,000 volt radiation machine in the Betatron building is the largest of its kind in the world.

The climax of this big engineering weekend at Illinois will be St. Pat's Ball. The first St. Pat's ball was held in 1934. It was such a success that it was established as an annual affair for engineering students. The war interrupted the festivity, but St. Pat's Ball was revived again in 1948. Now again this year, the engineering dance will climax the series of elaborate events on North Campus. Deserving seniors in the College of Engineering will have the title "Knight of the Order of St. Pat" bestowed upon them, as St. Pat himself will be present to perform the knighting ceremony. Then, as the dancing ends at midnight, the 1952 Engineering Open House will have come to a close.

BILGE . . .

(continued from page 12)

zip away from a stop like a steamer.

The steam car gets along very well without an ignition system, transmission, clutch, right-angle drive at the differential, or a driveshaft. The steam car can burn almost any liquid fuel and will not freeze up in winter weather. It cannot stall and can move away from a stop either at a snail's pace or so fast that it leaves two long streaks of rubber on the pavement.

Although there are still many difficulties to be overcome, much work on the steam car is being done in Europe and elsewhere. There is talk of a really modern steam car being in the development stage right now. The steam car is not dead!

The NYU Quadrangle recently printed the results of a survey taken of the '51 engineering graduates from NYU. This survey asked the graduates what they were doing, what their starting salary was, and how they obtained their jobs.

Two things are notable from the survey on what the graduates are doing now. First of all, there were no reports of unemployment; and secondly, a much larger percentage of the engineering graduates were getting government jobs. Following are the statistics:

Private Industry Engineering	72%
Civil Service Engineering	16%
Graduate Study	3%
Armed Services	9%

Data on the starting salaries of graduates shows a general rise in salaries. Following is a breakdown by the different fields of engineering.

	Median Starting Salary per Month	Average Salary
Aeronautical Eng.	$287	$287
Chemical Eng.	316	306
Civil Eng.	300	313
Electrical Eng.	288	288
Eng. Physics	277	292
Industrial Eng.	302	309
Mechanical Eng.	300	308
Meteorology	258	258

Another interesting survey was on how the graduates obtained their jobs.

Placement Bureau	27%
Faculty	13%
Answered Newspaper Advertisement	13%
Private Employment Agency	7%
Public Employment Agency	1%
Direct Personal Inquiry	19%
Family or friends	15%
Engineering Societies or Publications	5%

First Roommate: "Have you got a picture of yourself?"

Second Roommate: "Yeah."

First Roommate: "Then let me use the mirror. I want to shave."

Pre-med Instructor: "What are the names of the bones in your hand?"

Freshman: "Dice."

Jack: "What's the best way to teach a girl to swim?"

John: "Well, first you have to put your arm around her waist, then gently take her left hand and . . ."

Jack: "It's my sister."

John: "Just push her off the dock."

"Had some tough luck in court this morning."

"How's that?"

"Arrested for kissing a woman, then the judge saw the woman and fined me ten dollars more for being drunk."

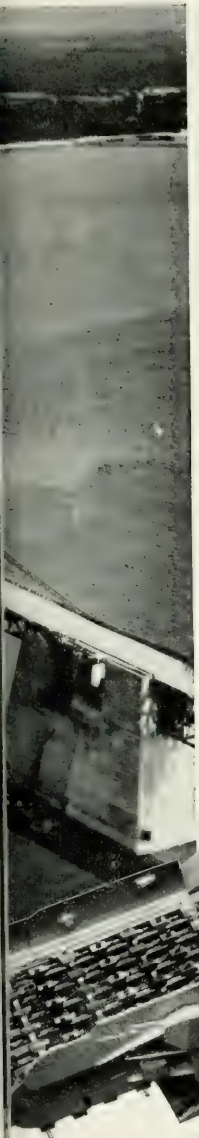
Two boys returning from Sunday school were discussing what they had learned. "Do you believe all that stuff about the devil?" one asked.

"Naw," replied the other, "it's just like Santa Claus—it's your old man."

Prof: "I believe you missed my class yesterday."

Student: "Why, no, I didn't. Not in the least."

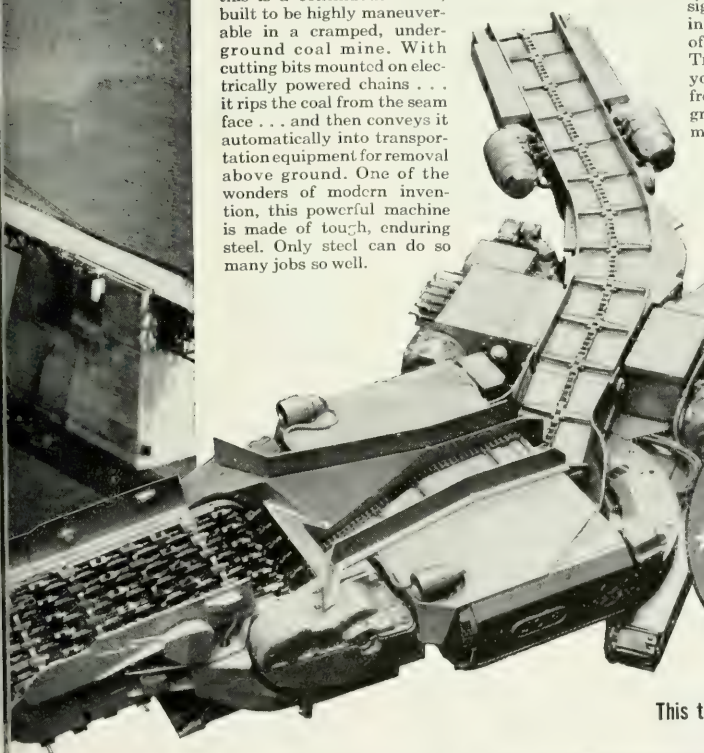
o well



FLOODWALL OF STEEL. 76 earth-filled cells like this, built of interlocking U·S·S Steel Sheet Piling, protect a Kentucky rolling mill against flood waters in the Ohio River Basin. Because of its great strength, long life, and low installation cost, this product of U S. Steel is invaluable in all types of projects involving control of earth and water.

EASY WAY UP FOR A FAST TRIP DOWN. Skiers at Sun Valley find this "chairway" designed and built by U.S. Steel, a big help in mounting the world famous ski slopes of this popular Idaho resort. U.S. Steel's Tramway Division can design and build you anything from passenger tramways to freight tramways for transporting sand, gravel, coal, lumber, ore, limestone and many other materials.

STORY-BOOK DRAGON? No, this is a continuous miner, built to be highly maneuverable in a cramped, underground coal mine. With cutting bits mounted on electrically powered chains . . . it rips the coal from the seam face . . . and then conveys it automatically into transportation equipment for removal above ground. One of the wonders of modern invention, this powerful machine is made of tough, enduring steel. Only steel can do so many jobs so well.



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SKIMMING . . .

(continued from page 14)

In many fields once exclusively served by lumber, metals have taken over because they have been available as "package" items. The lumber industry admits that it has lagged behind metals and plastics industries in design and utilization, but now it feels that it is catching up again.

Industry spokesmen point to the tremendous growth of the plywood industry as an initial step forward. By fabrication with the newly developed gluing technology, superior stress factors can be achieved and they can now give military and civilian designers a product designed for particular needs, they say.

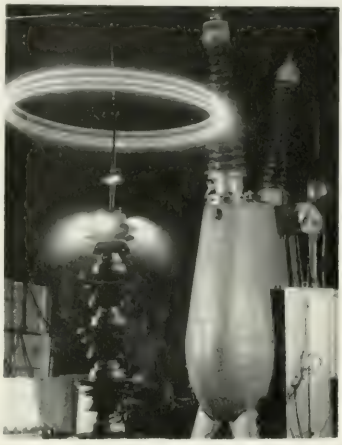
For example, wooden spans instead of steel could save as much as 300 tons of steel in one airplane hangar. And laminated timbers have equal strength in the flash fires that occasionally occur in aircraft hangars and such structures.

A saving of about 95 per cent of scarce metals can be made by using fabricated timbers as residential, commercial, industrial, school, church and bridge trusses.

Industry spokesmen say in most cases extensive research will not be needed for lumber to replace metal. For instance, in the case of kitchen cabinets, wardrobes, bathroom cabinets, door jambs and sliding doors, the minimum percentage of saving would be 90 per cent, and none of these would involve more than a few minor changes in design.

million-volt "corona motor"

Engineers at the Westinghouse high voltage laboratory created this pinwheel effect while demonstrating the phenomenon of corona, the leakage of power at high voltages. The "corona motor" is simply three "L"-shaped rods connected to a hub that rotates atop a vertical rod projecting from an insulator. When one million volts is applied, the "jet" action of the corona discharge from the trailing tips of the bent rods causes the assembly to rotate. The apparatus in the background is a newly developed "watch-case" circuit breaker.



automatic marine pilot

A completely automatic marine pilot system, which can be set to follow any course, has been developed for the U. S Navy by GE.

A helmsman may tend to overcompensate for wind, swells, and currents, but the auto-pilot guides the rudder through a chosen course with an average variation of less than one-half of one degree. Aside from smoother sailing, fuel savings also result from the reduction in rudder movement.

Special features of the system include an automatic compensator which trims the ship when there is more force or resistance on one side of the vessel than the other. A weather adjustment minimizes rudder action in heavy seas, thus cutting down hull stresses. In emergencies an override permits the helmsman to take the ship immediately from automatic control and place it under manual operation. An automatic turn compensator keeps the ship from maneuvering past the desired compass heading in completing a turn.

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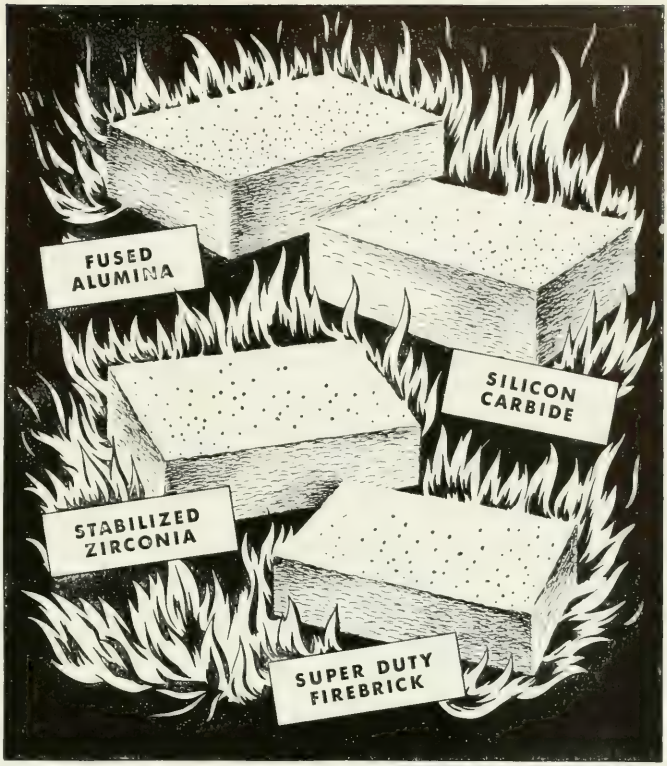
213 C.E.H.

Which of these Refractories *withstands the* Highest *temperature?*



If you answered "Stabilized Zirconia*" you're right up to the minute on the latest developments in the refractory industry. Norton Fused Stabilized Zirconia . . . an amazing new refractory . . . withstands temperatures up to 4500°F. Because it makes higher temperature ceilings possible, Norton Stabilized Zirconia opens the doors to new technical advances in the processing field . . . has already speeded up gas synthesis production by a profitable margin.

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Even more amazing is the *electrical resistivity* of Norton Fused Stabilized Zirconia . . . ranging from 2300 ohm-cm at 1300° F to 0.37 ohm-cm at 4000°F. Yes, it's just the opposite to the usual rule that resistance increases with the temperature.

Equally valuable to processing industries is the *chemical stability* of Norton Stabilized Zirconia, manifested in its ability to resist both oxidizing and reducing atmospheres at high temperatures and its chemical inertness in contact with titanates.

Thinking of Your Future?

First to produce Fused Stabilized Zirconia in commercially significant quantities, Norton keeps on "making better products to make other products better" through constant work on new developments. To do this requires new ideas and fresh approaches in the field of research . . . a hint to young engineers and chemists. When you think of your future, think of Norton.

New Bulletin

describes the amazing properties of Norton Fused Stabilized Zirconia in full detail. Write for a free copy.

Neil Ault, Ph.D., Ohio State '50, measures the resistance to deformation of Crystolon* (SiC) refractories at high temperatures in multiple load test furnace.

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U. S. SURVEYS . . .

(continued from page 10)

which has been furnished you has reference to the heavy of the explorations under the direction of the Chief of Engineers of those portions of the United States territory lying south of the Central Pacific Railroad embracing parts of Eastern Nevada and Arizona.

The main object of this exploration will be to obtain correct topographical knowledge of the country traversed by your parties, and to prepare accurate maps of that section. In making this the main object it is at the same time intended that you ascertain, as far as practicable, everything relating to the physical features of the country, the numbers, habits, and disposition of the Indians who may live in this section, the selection of such sites as may be of use for future military operations or occupation and the facilities offered for making rail or common roads, to meet the wants of those who at some future period may occupy or traverse this portion of our territory.

In ascertaining the physical features, your attention is particularly called to the mineral resources that may be discovered, and, where the indications would seem to justify it, you should have minute and detailed examinations made of the locality and character of the deposits.

The influence of climate, the geological formations, character and kinds of vegetation, its probable values for agricultural and grazing purposes, relative proportions of woodland, water, and other qualities which affect its value for the settler, should be carefully observed.

The latitude and longitude of as many as possible of the important points should be accurately determined, and in order to assist you in this it is suggested that you make arrangements with the officers in charge of the United States Lake Survey and the United States Naval Observatory, so as to determine by telegraph the longitude of those points nearest to your field of labor, with which your field work can be connected. . . .

You will use your own judgment in modifying the plan proposed in the event of any unforseen circumstances or physical obstacles preventing an adherance to it.

To aid you in the discharge of these duties, Lieut. D. W. Lockwood, of the Corps of Engineers, has been ordered to report to you, and you are authorized to employ ten assistants as topographers, geologists, naturalists etc., at salaries already authorized from this office in letters of previous date; also the necessary number of packers, guides, and laborers to complete your party, the whole number of civilian employes not to exceed thirty in number. You will procure your assistants, employes, and equipment, supplies, etc., at those points which seem to insure the most economical and effective organization for the party, and are authorized to pay their actual transportation to and from and to subsist them while in the field. . . .

You will communicate with this office as often as the means of communication will allow, forwarding the usual reports and returns required by the regulations, and such other reports as will keep this office apprised of your movements, and the progress of the expedition under your charge. . . .

I am respectfully, your obedient servant,

A. A. HUMPHREYS
Brigadier-General and Chief of Engineers.

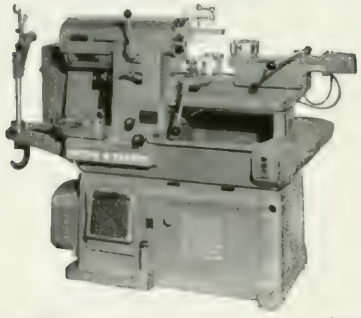
Lieut. GEORGE M. WHEELER, Corps of Engineers, Washington, D. C."

In order to carry out the provisions of this letter, Wheeler surrounded himself with men of highest calibre in the various fields. His course of action at this time was to prove a very wise one in later hazardous situations.

In further instructions it was decided that the country was to be mapped on a scale of one inch to eight miles. Distances over the trails were

(continued on page 26)

NEW BROWN & SHARPE HAND SCREW MACHINES



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Television is enjoyed in more than 15 million homes, as a result of research at the David Sarnoff Research Center of RCA at Princeton, N. J. Today's image orthicon TV camera was perfected there. Dr. Vladimir K. Zworykin of RCA developed the *kinescope*—which is the screen of television receivers. And RCA scientists have also perfected electron tubes, circuits, sound systems, phosphors, and antennas to make television part of everyday life.

The development of modern all-electronic television is only one example of RCA research at work. This leadership assures you high quality performance from any product or service of RCA and RCA Victor.

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U. S. SURVEYS . . .

(continued from page 24)

carried with an odometer, a wheel trailing along behind a mule. Describing this particular device, one writer who accompanied a Wheeler survey party said: "To see the odometer on a steep mountain trail is better fun than a circus; as it wobbles along a good road it excites the curiosity and conjecture of the natives, to whom the one wheel without a body is the acme of ludicrous uselessness. . . ."

All elevations were determined with an aneroid or cistern barometer, and in spite of the disdain which this instrument is accorded today remarkable results were obtained.

The maps were controlled horizontally by triangulation stations established on prominent peaks. The observations were made with a transit theodolite with a five-inch limb and reading to five or ten seconds of arc. These instruments also served to record angles for the station traverse sheet. Between main stations topographic meander stations were established to fill in details of topography not visible from the main stations.

Base lines for the triangulation system were measured with wooden rods, 20 *ft.* in length. These rods were compared daily with steel rods of the U. S. Coast Survey.

At all camps observations were made for latitude. Longitude observations were also carried out where access could be had to transcontinental telegraph circuits. Signals were received from the observatory of the United States Lake Survey at Detroit or the Naval Observatory in Washington.

A vivid description of the latitude determinations is given by aforementioned writer. "The observations for latitude are continued at nearly every camp, and when other members of the party are chatting around the camp fire, the astronomer retires to a dark, quiet spot with his instrument, and lying on his back, or resting his elbow on the rough ground, occupies himself with the stars, which never seem so cold, so far, nor so brilliant elsewhere as they do from a peak in the Sierra Nevada. He is assisted by a recorder for time, who, with an open watch and a lantern before him, records the hour, minutes, and seconds in response to the word 'tick,' which the astronomer utters at each observation. These two men, isolated and scarcely revealed by the flash of the fire and the yellow gleam of their lanterns, make a picture, and when the night is frosty, the picture is one of misery."

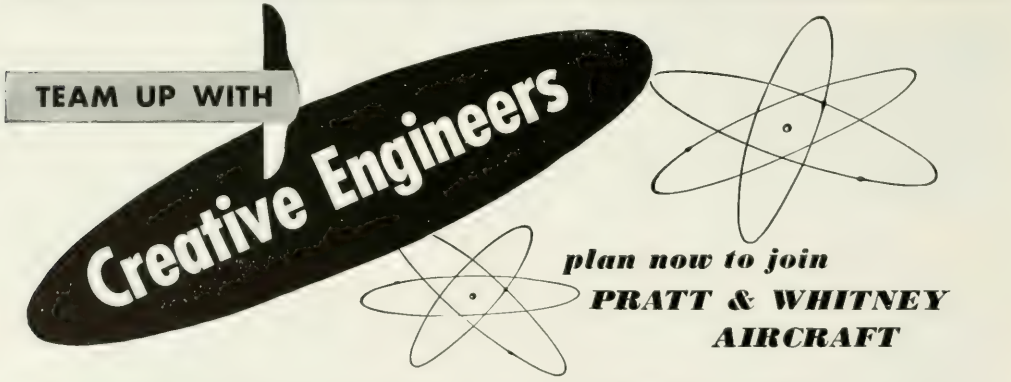
Besides the formal work required at each camp site and at each triangulation station the recorder had considerable duties. Among these were the " . . . entering of the aneroid readings at each station of the route, . . . the character of each camp, as to wood, water, grass, and other camping facilities. He also notes the general character of the country, its opportunities for travel, the nature of the landscape, the amounts of timber and grass, and information concerning springs, streams, etc."

In addition to the topographic work, scientists were detailed with the various parties to secure data on the geologic features of the country, its flora and fauna and ethnology and archaeology. However, only that part of the operations dealing with topographic mapping and exploration will be discussed here.

Seasonal Expeditions

The Wheeler survey parties were in the field eleven seasons. The most fruitful of the expeditions and certainly the most interesting was the expedition of 1871. This expedition caused Wheeler to note: "When the large latitudinal and longitudinal expanse, the extensive area, the long lines traversed, the broken mountain and desert tracts entered and for the first time made known as a whole, the multiple number of parties, their successful connection and co-operation, over a country where supplies had to be transported to advance depots, is

(continued on page 30)



FOR over a quarter of a century the Pratt & Whitney Aircraft Division of United Aircraft Corporation has depended upon *creative engineering* to bring its products to the forefront.

How well this idea has worked is amply demonstrated by the outstanding leadership record which Pratt & Whitney has established in both piston and turbine aircraft engine types.

And for the future, because of its sound engineering background and research facilities, Pratt & Whitney is one of the few companies in the country to be selected to develop an atomic powered engine for aircraft.

Creative engineering will continue to be given top emphasis at Pratt & Whitney—and it might well be the best answer to *your* future too—if you want a chance to put *your own* ideas to work.

Why not find out where you could fit into this great engineering organization? Consult your Placement Counselor or write to Frank W. Powers, Engineering Department at

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When You Find the Work You Like

STAY WITH IT!

GORDON W. CLOTHIER

by GORDON W. CLOTHIER, *Manager, Transformer Section, Electrical Department*
ALLIS-CHALMERS MANUFACTURING COMPANY (*Graduate Training Course 1938*)

THAT'S a good plan, but there's just one little catch in it; sometimes it takes a good while to *find* the work that's right for you. If you're worried about that, perhaps my own experience will point out a practical shortcut.

I got my E. E. at the University of Washington in 1935, and went on with graduate work and teaching for another year. Then—into the practical business world. That's when I found the shortcut. I enrolled in the Allis-Chalmers Graduate Training Course in 1936, and very soon I got interested in the big transformers. I've been with them ever since, and they've given me a lot in accomplishment and satisfaction.

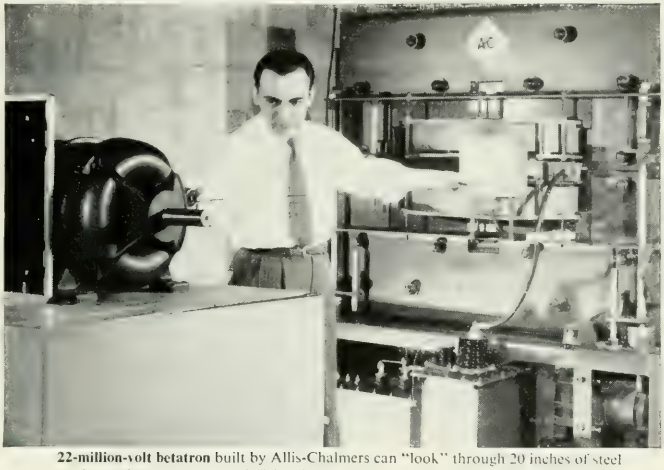
Back to Stay

Of course, during two years in the Graduate Training Course I got around a good deal in the big West Allis works. Had some time in the shops, got acquainted with the work of many departments, tried my hand at design, test, sales application work. But I came right back to transformers and have always been a lot more satisfied because I'd seen a broad range of other types of products and work at Allis-Chalmers.

In 1941 I became engineer in charge of transformer sales, and in 1947 was made manager of the transformer section.

This field offers both challenges and rewards. It needs and seeks men of superior intelligence, imagination and creative ability—men who will strike out into new paths of study and development.

If you think a transformer is an inert mass of iron and copper windings in a tank of oil—look closer. There are advanced problems in magnetostriction that if solved, will eliminate transformer hum and revolutionize the business. It's the same with problems in metallurgy, insulation, measurement and control of electric field shapes and the effects of time on materials. Perhaps some young engineer, even during his Graduate Training Course days here, may make important contributions. The opportunity is waiting.

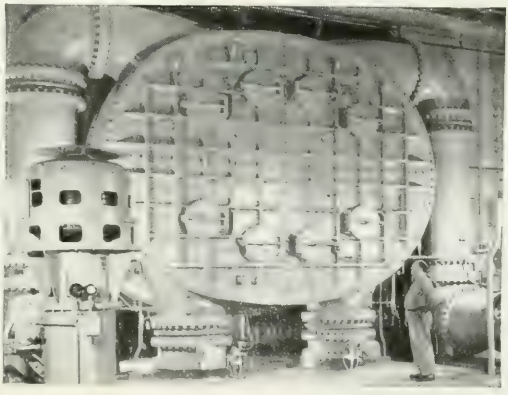


22-million-volt betatron built by Allis-Chalmers can "look" through 20 inches of steel to detect flaws. Here a technician is setting up motor specimen for radiography.

What Do You Want to Do?

It's the same in other departments at Allis-Chalmers. Ore processing methods and machinery—electronic equipment—public works—steam turbine and generator design—hydraulics—manufacturing—research—sales—they all hold opportunities. Here you'll have a chance, as a Graduate Training Course engineer, to look over the widest range of industrial fields covered by any manufacturing firm in the country. You can help plan your own course, get advanced degrees. It's a shortcut to finding the work of your choice.

Write for information and literature, or call on the Allis-Chalmers district office in your locality.



Two-pass 45,000 sq. ft. surface condenser and two 42" x 30" vertical mixed flow pumps. Allis-Chalmers oval design saved space in this big new power plant.

ALLIS-CHALMERS A-C

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin

CAPITALIST!

Johnny used to be a laborer. Brother Tim still is.

Both cut lawns. Both used to use customers' hand mowers. Each could do one big lawn a day, and got $2 for it.

Tim spent his $2 on movies and candy. Johnny saved some money, borrowed some more, and bought a power mower. Now he can cut 5 lawns a day, and so makes $10.

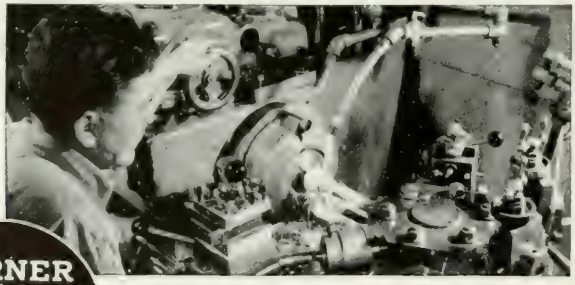
He puts aside $2 a day to pay back his loan, and $1 toward another mower when this one wears out.

He still has seven dollars where he used to have two, and is helping more people get their lawns cut when they want them. Yet some enemies of business would say that that shows Johnny is too big; he should be limited in the number of people he can serve.

These same strange enemies would prevent Johnny from setting aside $1 a day out of his own earnings, to buy a new mower when this one wears out. (Of course, that means Johnny would go back to hand labor at $2 a day, and fewer people would be served—but these strange people don't care about that.)

And some people say Johnny should be forced to share his $7 with Tim so Tim can keep on spending his $2 for movies and candy.

Sound ridiculous? Yes, but every one of these charges and demands is leveled at American business today.



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Carbide . . . and Acetylene are just two of the many products of the Air Reduction corporate family . . . a group that contributes to practically every phase of American life — and industry . . . serving such diversified activities as medical therapy and soft drink carbonation . . . flame cleaning and synthetics.

In fact, wherever progress is racing ahead to new frontiers, you find an *Air Reduction Product.*

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U. S. SURVEYS . . .

(continued from page 26)

considered, and when taken in connection with the successful ascent of the Colorado, . . . together with the fact that the region south of the Colorado River as well as part of those to the north of it, were infested by hostile Indians, making a perpetual guard a necessity by night and day, all of this, coupled with the unflinching courage, perseverance, and tenacity of the *personnel*, make it apparent that the exploration of 1871 was one of the most important and useful of those intrusted to my charge during eleven expeditionary years."

The reference to the Indians is timely, for it was during the season of 1871 that three members of a Wheeler survey party were murdered by the redskins at Wickenburg, Arizona. The perpetrators of this crime were later tracked down by the sleuthing of one of the braves that accompanied Wheeler on the ascent of the Colorado. Although the Indians rendered valuable service to the survey at times, Wheeler felt considerable bitterness towards them, looking forward to their "extermination as a race."

A description of Indian life is found as a caption to Plate XI in the Surveys' Geographical Report. The scene is "at one of the Navajo wick-e-ups. (The hut used by nomadic Indian tribes of the arid regions of the western and southwestern states, typically elliptical in form, with a rough frame covered with reed mats or grass or brushwood), near Old Fort Defiance, and is . . . (one) of everyday . . . life. The head and lord of the family looks on with phlegmatic equanimity at the patient industry of the squaw and indulges in day dreams, undoubtedly of victories of war or excitement of the chase performed by him or his ancestors. They gather a scant harvest of corn and grain, but depend now for the greater part upon Government rations."

The expeditions, while often arduous in nature, toured regions of historical interest. One such place was Lee's Ferry, Arizona. Major John Lee had established a ferry on the Colorado River above the Grand Canyon for the benefit of emigrants on their way to California. Lee was a well-known "Mormon desperado and leader of the Mountain Meadow massacre." He was later shot standing in his coffin to expiate for his crime under the law.

An expedition investigated the Pueblo Indian ruins in the Chama and Chaco River valleys in New Mexico. These dwellings were first seen by Cabeza de Vaca, a member of the Spaniard Narvaez' expedition of 1528.

It was near the aforementioned ruins that an unusual meteorological condition was observed. "Snow covered the ground 4 inches in the morning. So far as is known there has never before been recorded within one horizon at one time in different parts of the heavens, rain clouds, the moon visible in a clear sky, with thunder and lightning, hail and snow, all recurrent within an hour."

Start of Wheeler exploration of the Colorado River from Camp Mohave, Arizona.

The weather at times plagued the survey parties. The expedition in the Death Valley was one of special hard-

(continued on page 34)

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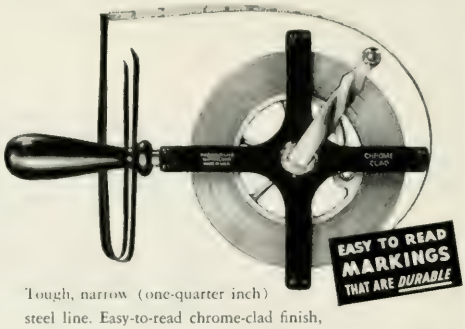

Tough, narrow (one-quarter inch) steel line. Easy-to-read chrome-clad finish, has jet black markings on chrome-white background. Line is extra heavy (.020" before multiple plating). Marked 10ths and 100ths ft., or feet, inches and 8ths. An especially durable tape mounted on a sturdy frame with extra long, self locking, winding device and hardwood carrying handle. Furnished with 2 leather thongs.

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ORDVAC . . .

(continued from page 7)

ing with a high speed electronic memory of the kind used in ORDVAC.

The Bureau of Standards laboratories have two machines with memories of the ORDVAC type, but each stores only 512 digits per tube as compared to 1,024 in the Illinois machine. The Massachusetts Institute of Technology has a machine which can do arithmetic faster than the ORDVAC, but its memory is only one-third as great.

One other ORDVAC type machine is now under construction at the Institute for Advanced Study in Princeton, N. J., where fundamental work pertaining to this type of machine was originally carried out by Prof. John von Neumann and coworkers.

Problems, with working directions coded in numbers, are put into the ORDVAC at Illinois through a teletypewriter, and the results are typed out by the teletypewriter. This is the input-output unit, and is the slowest part of the machine.

One problem given the "electronic brain" was to calculate, successively, the cubes of all numbers from 1 through 2,000. The teletypewriter tapped out the answers—1, 8, 27, 64, etc.—at five strokes a second. It took an hour and a quarter to print the 2,000 answers. The teletypewriter never paused, but the "brain" was loafing practically all of the time. It could have given all the solutions in two seconds!

Professor Ralph E. Meagher and his staff at Illinois plan to make the teletypewriter run five times as fast it does now, but this still will be far behind the electronic brain's speed. However, it will not slow the machine because in most work—unlike that of calculating the cubes—the "brain" will carry out a lot of computations, one after another and involving each other, before typing out the final answer.

One of the machine's complicated "exams," for example, was to generate 352 random numbers, carry out a complicated routine of multiplication, division, and comparison of answers, and do this job over and over again, each time giving itself a new set of numbers, to stop if it made an error, and if all was well, to report progress every time it did the job.

The teletypewriter tapped out a report line every 45 seconds. The test was continued for 12 hours, just to make sure the machine was running properly and was consistent in its action.

Other test problems presented to the machine were some which had previously been worked by other—and much slower and more tedious—methods, and for which the engineers could "look in the back of the book" to check the electronic brain's answers.

INTRODUCING . . .

(continued from page 16)

exhibit for the 1952 I SEE. He has also found time to serve as secretary of the IES, become a member of Scabbard and Blade, military honorary, and, as a Major in the AFROTC, to belong to the Arnold Air Society. On the more social side, John is a member of Alpha Sigma Phi social fraternity and

JOHN UNDERWOOD

was chosen as one of the Hundred Outstanding Seniors.

As for the future, John will receive his degree in illuminating engineering from the department of electrical engineering this August and will probably enter the Air Force.

In August either the Air Force will receive an outstanding officer or industry will gain a fine engineer; in either case, Illinois will lose one of its best head cheerleaders.

Did you volunteer or were you drafted?

Well, it was like this: My number came up, I had no dependents, and I passed my physical, so I volunteered.

* * *

The seven-year-old son of a radio comedian came home with his report card.

"Well, son," asked the radio star, "were you promoted?"

"Better than that, Pop," chirped the kid happily, "I was held over for another 26 weeks."

* * *

Procrastination is the thief of time and so is every other big word.

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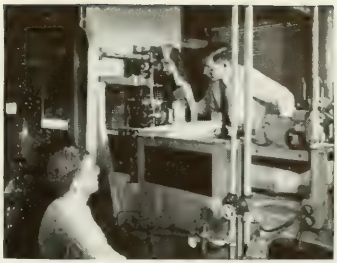
THE DU PONT DIGEST



SEEKING *new ways to coat plastic on wire: Carl Hellman, B.S.Ch.E., Syracuse '50; and J.M. McKelvey, Ph.D.Ch.E., Washington '50.*

Ch. E's at Du Pont

The fields of research and development invite ingenuity of the chemical engineer

[SECOND OF A SERIES]

Research and development work in chemical engineering often overlap at Du Pont, except where the research is fundamental.

The chemical engineer occupied with fundamental research is chiefly concerned with basic studies of unit operations and processes involving reaction kinetics, thermodynamic properties of fluids, high-pressure techniques, equilibrium studies, heat transfer and the like. Such studies often lead to lower-cost manufacturing processes. Some recent projects in fundamental research have been:

1. A study of fluidized catalyst reaction units including degree of fluidation, temperature uniformity, catalyst activity and life, and conversion of feed gases.

2. Studies of the fundamental transfer relations between phases, for instance, gas and liquid, in reacting materials.

Apart from the chemical engineers engaged in fundamental research, there are many groups working in applied research and development. In fact, this is the major part of the chemical engineering work done at Du Pont. Here are examples of the literally hundreds of unusual problems they have solved:

1. Designing equipment for producing pure silicon at 1000°C. (Though one of the starting compounds is highly corrosive, only spectroscopic traces of impurities can be tolerated.)

2. Developing a high-pressure liquid-phase process to replace the standard dry method of producing sodium azide formerly employed.

3. Designing a continuous flow, gas-liquid reactor for use in making a fiber intermediate under pressure.

4. Developing, from laboratory research results, a process for large-scale production of complex polymeric materials used in the manufacture of color photographic film.

These examples can only hint the variety and originality of problems constantly arising at Du Pont. They indicate the challenge as well as the broad opportunity awaiting the talents and ingenuity of the young chemical engineer who wants a career in research and development.

NEXT MONTH — The chemical engineer's role in plant operation at Du Pont will be discussed in the third article in this series. Watch for it!

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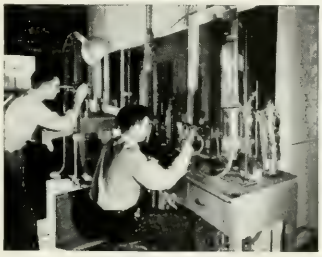
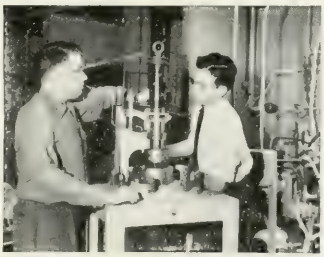


MEASURING *pore-size distribution of porous media used in filtration: Harold P. Grace, B.S.Ch.E., Univ. of Pennsylvania '41; and Nym K. Seward, B.S.Ch.E., Lehigh U. '47.*



INSPECTING *a new type of high-pressure reactor: Robert J. Stewart, B.S.Ch.E., Rensselaer Polytechnic Institute '50; and Henry Smithies, M.S.Ch.E., University of Michigan '50.*

STUDYING *plate in stainless-steel tower used to determine efficiency of designs: C. M. Gamel, Jr., S.M.Ch.E., M.I.T. '48; and J. B. Jones, M.S.Ch.E., University of Michigan '46.*

U. S. SURVEYS . . .

(continued from page 31)

Sept. The route lay for more than 80 miles in light, white, drifting sand, which was traversed between 2 a. m. and 6 p. m., the center of the desert being reached about meridian. The stifling heat, the great radiation, and constant glare from the sand were almost overpowering, and two of the command succumbed near night fall, rendering it necessary to pack one man on the back of a mule to the first divide on the route, where a grass sward was reached at the end of the long, sandy stretch, while the second, an old and tried mountaineer, became unconscious for more than an hour in the same locality. This happened fortunately, near 6 p. m., when the sandy waste was mostly behind us. With water from the canteens these men were restored to consciousness, and the march resumed by moonlight, without trail or guide. A living stream was reached between 3 and 4 a. m., at the eastern base of the Inyo Range, after a continuous march of over twenty-three hours."

Lengthy marches were common on the expeditions. These were treks of "from 60 and even 80 hours with scarcely a halt." Although the destination was usually known, sometimes a blunder found the party on the wrong course as was experienced on a survey in Oregon; Wheeler writes, "The march was resumed the following day, expecting to reach Fort Klamath, but as luck would have it, a road forking in the heavy timber was taken for the main one on account of its fresher tracks and apparently more frequent use. This proved, however, to be the old Eugene City wagon road, and brought the party just at dusk to a little stream with abrupt banks, the bridge over which had gone to decay, thus stopping further progress. Reference to the topographic notes showed an erroneous course. . . . After a short rest and supper the back track was taken by moonlight and camp made at about 3:30 a. m. near the fork of the roads."

As would be expected from surveys as extensive as these many discoveries were made and places reached never before visited by white men. In extending their lines of triangulation into Colorado, topographers of the Wheeler survey occupied for the first time Cerro Blanco Peak, 14,270 feet above sea level.

High places were familiar to the topographers, for at the close of work in 1879 they had "determined the heights of 395 peaks (with names, many of which are new) above 10,000 *ft*, and of 754 others (with names) between 5,000 and 10,000 *ft* in height." Also the plotting of the "location and profile of 202 mountain passes. . . ."

Taken as a whole the general expeditions of the United States Geographical Surveys West of the One Hundredth Meridian added materially to the knowledge of that part of the country in which they were engaged. These surveys were executed with a minimum number of men at a time when foreign governments were expending considerable sums for similar work. The $691,444.45 expended for the Wheeler surveys during their 11 year existence brought forth the most profound survey executed to that time.

Special Explorations

Without a doubt, besides the seasonal expeditions, the survey of the Grand Canyon of the Colorado was the most monumental accomplishment of all. The primary purpose in making the survey was to determine the practical head of navigation. However, a geological investigation was also desired and for this purpose the famed geologist G. K. Gilbert was retained to accompany the party.

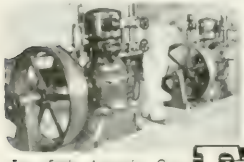
The party for the ascent of the river was organized in September, 1871. It consisted of Lt. Wheeler, chief; P. W.

(*continued on page* 36)

Fruit Storage Stops Shrinkage with New Frick Refrigerating System

Gillan Brothers maintain relative humidities of 85 per cent or higher in their 40,000-bushel apple storage at St. Thomas, Penna., even with temperatures of 32-33 deg. F.! These humidities keep the moisture where it is wanted—in the fruit.

This remarkable cooling system is equally desirable for storing vegetables, nuts, hides, textiles, and other products. Covered by patent applications, the new Frick system is revolutionizing cold storage practice.



The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

Two Frick Ammonia Compressors Used for Cooling Gillan Brothers' Apple Storage

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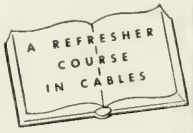

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The automotive and petroleum industries have overcome the problems of "hot engine sludge," or high-temperature deposits and varnishes collecting on vital parts—through chemical research that has led to both better refining methods and development of additives that have eliminated these difficulties.

The new additives have a triple role. They improve oil stability through inhibiting oxidation. They prevent bearing corrosion. And, through their detergent action, they eliminate deposits from fuel or other sources—thus supplementing improved refining methods.

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Intensive research to develop even better additives goes forward at our Whiting laboratories. Here is a challenging opportunity for young men with advanced training in chemistry and engineering. In projects devoted to additives, they can have a part in petroleum progress that will strengthen national production and military preparedness wherever severe engine service requires "heavy duty" lubricating oils.

Standard Oil Company

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STANDARD

U. S. SURVEYS . . .

(continued from page 34)

Hazard topographer, G. K. Gilbert, geologist; Dr. W. J. Hoffman, naturalist; T. H. O'Sullivan, photographer, E. M. Richardson, assistant topographer and artist; Frank Hecox, barometric assistant; six boatmen, six enlisted men from Camp Mohave, Arizona and Captain Asquit and thirteen other Indians of the Mohave tribe.

The marine equipment consisted of four little boats with sails and one barge for transporting food and equipment, the latter the property of the Quartermaster's Department.

The expedition set out from Camp Mohave on September 16, 1871. A plate in the Geographical Report shows the party with the professional personnel in striped pants, waist coats and derbies, appropriate garb for such an undertaking!

The remainder of the month was spent in negotiating rapids of moderate dimensions at the southern approaches to the Grand Canyon. The Black Canyon was traversed and a meeting was effected with Lt. D. W. Lockwood who came by land with supplies to a camp below the Grand Canyon. Here on October 6, a crossing of a more treacherous part of the river was accomplished. Wheeler describing this particular crossing writes, "All the animals are brought across by swimming the fierce current with a single loss. Mr. Gilbert proceeds with his boat to the mouth of the Grand Canyon with a view of making a geological section at this point. He succeeds in reaching the high mesa, about 3,500 *ft.* but is unable to return to the bed of the river before dark, and makes his camp high up in the rocks."

Wheeler was continually disturbed by the Indians accompanying the party, for he continues, "The Mohaves have a great feast over the animal that was killed in crossing, and in consequence many are sick; but the presence of a Pah-ute medicine-man has its influence in relieving the pains of the overfed aboriginals. A greater part of the day has been made hideous by roars, screams, and moans over the victims. For the third time the Mohaves have tried to desert and return to their homes. By dint of threats and persuasions they are, however, induced to remain until the completion of the river exploration."

On October 7, all was made ready to attempt the exploration into the Grand Canyon proper. The parties set out and managed to pass rapids of more pronounced dimensions. Wheeler notes on October 9, "The rapids are more formidable than any yet seen. I am satisfied that no one has ever ascended the river above this point, and Mr. Gass (a rancher who had explored the area below the Grand Canyon), . . . told me in 1869 . . . that he considered it impossible to penetrate further. It is for this party to try it however, and if successful, tomorrow there will seem to be little doubt of reaching Diamond Creek."

Diamond Creek was a rendezvous point above the Grand Canyon where a land party was stationed with supplies and food for the river crew. It was also the terminus of the exploration. The party for the Grand Canyon expedition was reduced to three crews of nine persons each. Entering the canyon the going became extremely difficult. The treacherous rapids almost destroyed one and another boat was destroyed for Wheeler recorded on October 11, " . . . the boat ran back against the rocks almost a perfect wreck, and its contents were washed down below the overhanging rocks. A stout case containing my most valuable public and private papers and data for a great share of the season's report, which for the first time had not been taken out of the boat at a portage, was lost, as well as valuable instruments, the astronomical and meteorological observations, and worse than all, the entire rations of that boat."

Continuing the account of the exploration in the Grand Canyon, Wheeler writes, "October 12.—Reached Camp No. 24, head of Disaster Rapid. The morning is occupied in searching up and down the river for any trace of articles lost from boat No. 1, but without success. Our party are all despondent, and as the boat swamped yesterday was badly damaged, and rations are very short, a portion of the party is here detached to make the descent in this boat, with expectation of reaching the land party and following their trail southward from the point on the river where the barge lies anchored. No one except Mr. Gilbert and myself think that the boats can pass the rapids in front of us. It requires no little courage to continue further on, since one day later would prevent a return in time to meet the relief party at the river crossing, and the barge has rations only up to a certain date. Mr. Gilbert and myself propose to reassure the men by taking the first boat across the rapid . . . half an hour before twilight a rope is stretched and the emergency prepared for. The entire force is stationed along the line, and the cast-off is made. In five minutes the worst part of the rapid is over, and just as the sun sinks gloomily behind the cañon horizon the worst rapid is triumphantly passed, amid the cheers

(continued on page 40)

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TENSION CONTROL
AND LEATHER
make a good team
TENSION-CONTROLLING MOTOR BASE
FLAT LEATHER BELT
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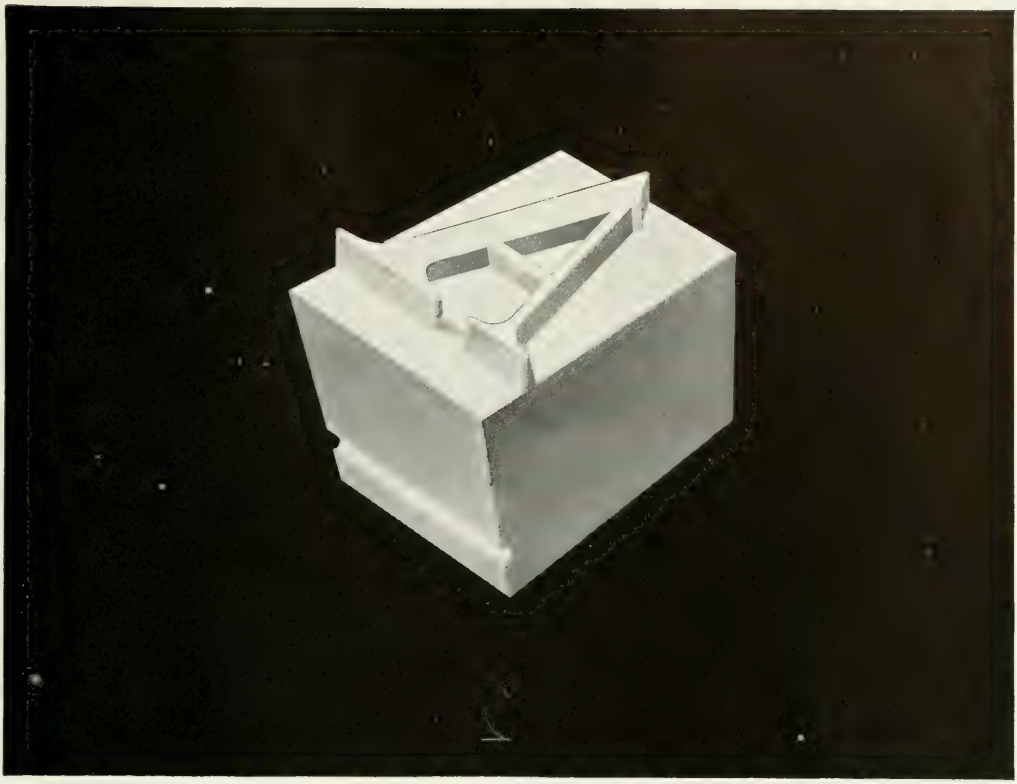

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U. S. SURVEYS . . .

Continued from page 504

and exultations of every member of the party." Later the other boat passed this rapid successfully, and the expedition continued. On October 14, six hours were required to pass "the worst rapids of the trip."

The loss of the rations for one of the boats at Disaster Rapid was cause for considerable concern. The trip extended for a longer time than calculated and members of the party were anxious to reach Diamond Creek. On October 17 the crew passed the "highest rapids yet —fall 10 ft. (canyon) width 35 *ft.* . . ." It was necessary for Wheeler to guard the rations personally.

Wheeler's narrative of the next day, October 18 follows: "River Camp No. 30, Look-ahead Camp. . . . The boats are leaking badly. Complete instructions are made for two messengers, Hecox and Roberts, who volunteered to start out in the morning to reach Diamond Creek. This seems a necessary measure, as the lives of twenty persons are now dependent upon the success of the messengers sent ahead for food. A fair-sized loaf is cooked for each, and they will depart at daylight."

The scientific nature of the expedition is not forgotten even in the face of adversity, for Wheeler reports on the same day, "Between 10 and 11 a. m., Mr. Gilbert saw plainly the planet Venus."

The messengers dispatched by Wheeler were able to contact the land party and help was secured. The expedition reached Diamond Creek on October 19, 33 days after leaving Camp Mohave.

Wheeler commended the 20 men, 14 whites and 6 Indians who survived the crucial trip on the most treacherous river in the United States and through the greatest canyon in the world.

Of the Grand Canyon Wheeler said, "The stupendous specimens of extended rock-carving that make up the system of the cañons have been partially described and made known. They stand without a known rival upon the face of the globe, must always remain one of the wonders, and will, as circumstances of transportation permit, attract the denizens of all quarters of the world who in their travels delight to gaze upon the intricacies of nature."

Among the other accomplishments of special parties was the mapping for the first time of Lake Tahoe in California and Nevada. This lake held a special charm for Wheeler who likened it to Lake Luzerne in Switzerland. The latter lake is known as the "Lake of Five Cantons" and the former could be called the "Lake of Five Counties."

In this area also is the famous Comstock mining district. The mining region was mapped and the results published on a special Atlas sheet of scale 1 *in* to 1500 *ft.*

While not a special survey, the determination of the elevation of Mt. Whitney in California, the highest point in the United States, is worthy of mention in this section. The method of determining elevations as mentioned was with the aneroid or cistern barometer. In addition elevations of peaks were determined by angles of inclination from points of known elevation. Considering the method and equipment, the results obtained were surprisingly accurate. Wheeler's parties found the height of Mt. Whitney to be 14,471 *ft* above sea level. This differs by 25 *ft* from the present accepted value of 14,496!

Published Data

The results of the survey were published in forty volumes. The general results are summarized in a seven volume set titled the *Report Upon the Geographical Surveys West of the One Hundredth Meridian*, volume one of which is the Geographical Report mentioned in this article. In addition numerous volumes of instructions for the field parties were prepared, and lists of collections of material by the other branches were printed.

The topographic information is contained in 50 Atlas sheets. The original outline for the surveys provided for 95 Atlas sheets, but the appropriations were suspended before the entire region was mapped. The fifty Atlas sheets encompass an area of 326,891 square miles.

The sheets are, except for a few special issues, all on a scale of one inch to eight miles as previously noted. All conventional signs are generalized and landmark buildings only are shown in the towns. The culture is in black including the watercourses. The topographic features are printed in brown and the entire map has a buff base. In their day these sheets were the only source of information on the territory west of the one hundredth meridian.

Achievement

The greatest advancement made by the Wheeler surveys was the one that led to their suspension. They fixed in the minds of the members of Congress the need for a systematic, unified survey of the United States, not just a topographic survey but a complete scientific investigation. This was the scope of the successor to the Wheeler survey, the newly formed United States Geological Survey, created by act of Congress March 3, 1879. Lt. Wheeler foresaw its possibilities. His lifelong association with survey and familiarity with the progress of foreign governments in such work impressed him with the need for such an organization. To Lieutenant George Montague Wheeler is all credit due for the brilliant leadership of the first great engineering survey in the United States.

Bell Hop: Did you ring, sir?
Irate Guest: No. I was tolling. I thought you were dead.

* * *

When a motorist who had crashed into a telephone pole and brought down the wires recovered consciousness, his hands were clutching the wires.

"Thank Heavens," he exclaimed, "it's a harp."

"AND THEN MY FATHER SAID — FAH TO THESE GEIGER COUNTERS, I KNOW RADIO ACTIVITY WHEN I SEE IT!"

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Another page for **YOUR BEARING NOTEBOOK**

How to keep a drill team from marking time

The swivel on a drilling rig has to carry the tremendous weight of drill pipe that's often three miles long. To carry this load while permitting the pipe to rotate as fast as 250 R. P. M., oil equipment design engineers use Timken® flat thrust bearings in the swivels. Due to line contact between rollers and races, Timken bearings have extra load-carrying capacity. True rolling motion and incredibly smooth surface finish of Timken bearings practically eliminate friction and wear. Costly breakdowns are prevented.

How swivels are mounted on TIMKEN® bearings

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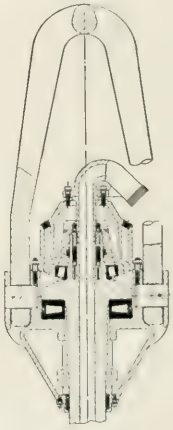

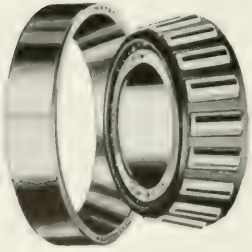

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BEARING TAKES RADIAL ⬭ AND THRUST —⬭— LOADS OR ANY COMBINATION ✳

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volume 67 number 6

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our cover

Here is a scene typical of almost any farm in the United States today. It illustrates the tremendous role the agricultural engineer has played in bringing machinery and technological advancement to the American farmer. Through agricultural engineering the United States has been able to increase farm production far beyond the expectations of our forefathers. (Courtesy CASE EAGLE, J. I. Case Company)

Our new cover designed by Lee Siple.

our frontispiece

The "Sentinel of the Plains" still has an important job although he is replaced by the automobile, jeep and airplane in many places. We acknowledge our indebtedness to the pioneer spirit exemplified in this picture by reviewing the contributions to agriculture and the range made as a result of their necessities. (Courtesy HARVESTER WORLD, International Harvester Company)

. . . We have only so much land on which to produce crops and livestock. Improved varieties of crops have been developed, the yields from which are far beyond the yields from the same crops in previous years. Soils have been put under terrific strain in the process, and lands have gone out of production for one crop and into production for another. Some lands have been abandoned altogether through misuse.

Others not previously used have come into production, either wisely or unwisely. But the fact remains that we have only a certain acreage of agricultural or potentially agricultural land available in the United States. This, in the face of a steadily increasing population, makes one thing sure: Future research must, above all, keep in mind the need to feed and clothe more and more people from a limited over-all acreage. The problem of land use, therefore, becomes paramount. They call for the best of scientific approaches. . . .

R. W. Trullinger in the 1950-51 Yearbook of Agriculture

ever-increasing opportunities in . . .

Vocations in Ag. Engineering

by Cerwyn Kline

Men who have chosen the agricultural engineering profession are often asked, "Just who are the agricultural engineers and what do they do?" To those who are embarking on a career in this branch of engineering the answer to this question provides an insight into the revolution of an industry. In less than half a century, this occupation has crystallized from the ideas of a few men, blossomed into a practical and technical science, and matured into a recognized professional branch of engineering. The potentiality for service of this group of engineers has just begun to be realized. The wide range of fields requiring technical engineering assistance offer ever-increasing opportunity for development and advancement. Now that the ground work has been laid and professional recognition obtained, agricultural engineers are limited only by their own foresight and imagination. Their predecessors have come a long way, but no forward looking agricultural engineer today doubts that this is only the preliminary step in a most promising field of professional activity and service.

Agricultural engineering is a composite branch of engineering, based upon the principles and utilizing the techniques and tools of many of the other engineering groups such as mechanical, civil, and electrical engineering. At the same time, agricultural engineering is characterized by its application to a single industry and is in this way similar to mining and automotive engineering. Unlike the other engineering branches, it must deal with the living biological forces of nature, as well as with the inanimate dynamic forces with which engineers are customarily concerned.

We have, today, new concepts of farm management, work simplification, the one-man farm, productive capacity, quality control, soil and water conservation, and a host of other ideas and practices which have made a more stable and more prosperous agriculture. Without the benefits of increasing agricultural production our nation would never have become the world power it is today.

When an agricultural engineer graduates from college, what can he expect to do? Who are his prospective employers? What are some of the fields in which agricultural engineers are well established and what are some of the newer activities in which an agricultural engineer might find employment? Agricultural engineers are employed in a surprisingly large range of activities. The following excerpt taken from an editorial which appeared in the *Agricultural Engineer*, will indicate the great diversity of positions open to agricultural engineers.

"A substantial number of members are employed in trade associations and individual companies in the engineering materials industries. The industries thus represented and interested in improving their service to farmers include aluminum, copper, brass, bronze, lead, nickel, steel, and zinc in the metals group, and asbestos, brick, limestone, glass, gypsum, petroleum, portland cement, tile, and vermiculite as well. The lumber, fiber, paints and coatings, and chemical industries can also be included in this group. Others may show up in the future.

The farm equipment industry is a natural place for their employment, in which agricultural engineers have proven their ability and earned increasing acceptance over a period of years. Still, there are quite a number of the smaller manufacturers who employ no agricultural engineers, or not enough of them to do their job. They include manufacturers of prime movers, small tractors, tillage equipment, pumps, irrigation equipment, harvesting and handling equipment, crop driers, prefabricated building and bins, pest control equipment, refrigerators, barn equipment, fans and blowers, and miscellaneous specialized items.

In the component parts classification, leading manufacturers of bearings, chains, tires, and wheels have members keeping a watchful eye on progress in the agricultural engineering field, and contributing to that progress. A token representation from the electrical manufacturing industry is doing the same.

Of more than 70 public utilities having agricultural engineers helping them serve their farm customers, more than half have only one each, and most of the rest have only two, three, or four.

(*Continued on Page* 18)

One phase of an agricultural engineer's studies is the testing of lubricating oils used for farm machinery. (Courtesy of Hadley Read)

the Technograph features the . . .

Agricultural engineering is now coming into prominence with the high degree of mechanization in agriculture. The agricultural engineering department at the University of Illinois is sharing in the growth of importance of the field of agricultural engineering.

The department has a current enrollment of about 50 students, well above the pre-World War II record. Also, a greater proportion of engineering students are enrolled in this department (about three per cent) as compared with one and one-half per cent of the engineering students enrolled before 1948.

The department is unique in the fact that it is a part of two colleges, engineering and agriculture. The department is administered in the college of agriculture and is a unit of the college, the Agricultural Extension Service, and the Agricultural Experiment Station. The professional curriculum is administered by the college of engineering and degrees are awarded upon authorization of the engineering faculty.

The department has been in the college of engineering since 1933, although the University of Illinois had a "professor of agricultural engineering" in the 1870's. Prior to 1900 and until 1922, the division of farm mechanics was in the department of agronomy. In 1922, it became a separate department. In 1933, it became the department of agricultural engineering and at that time the degree was authorized. In 1948, the master's degree in agricultural engineering was authorized and a series of graduate courses for students with degrees in agriculture were authorized in 1951.

The building in which the department is housed was constructed in 1905-06 as the Farm Mechanics building. In 1922, the tractor laboratory was added to the structure. At present, the Agricultural Engineering building contains the offices, laboratories, and classrooms of the department. In addition to the tractor laboratory, the building contains laboratory facilities for the study of farm machinery, internal combustion engines, and home utilities. Also located in the building are special research laboratories and a drafting room for design work.

HOWARD HADLER

Howie, a sophomore in agricultural engineering, is a life-long resident of Rantoul, Ill., and a graduate of Rantoul Township high school. After graduation and probably a short session with Uncle Sam, he hopes to get into industrial machinery work or go back to farming, which is his present summer occupation.

Besides being a member of the Tech staff at Illinois, he is active in the ASAE.

His hobbies—intermittent airplane model building and general tinkering.

In the tractor laboratory are several farm tractors and engines of the latest design. These tractors and engines are used for classroom work and performance testing. The laboratory also houses a dynamometer for the testing of tractor and engine power. Late models of all types of farm machinery are kept in the farm machinery laboratory and are used for study of machine components, principles, and design. One laboratory is devoted to research work on tractor valves. In other laboratories are electrical equipment of various kinds and other equipment for classroom work.

At present the building is highly overcrowded. To provide more space, a new research laboratory is being built. Construction of the building was started in the fall of 1951. The new building is a one-story structure, 45 by 200 *ft.* It will provide 9,000 square feet of research space for the department's extensive research and will be comparable in quality with other new buildings on the campus.

The department currently has 30 academic staff members. Professor E. W. Lehmann has been the department head since 1922. Professor R. I. Shawl has been with the department more than 30 years. Mr. H. P. Bateman was a member of the first graduating class, in 1934.

The department offers a four-year curriculum leading to a degree of Bachelor of Science in agricultural engineering with options permitting the student to choose between a power and machinery, farm structures, or soil and water engineering curriculum.

The power and machinery option includes the design of machines, the application of machines to farm use, and the development and use of materials for construction of machine components. The farm structures study includes study of design, location, and arrangement of buildings; lighting, heating, ventilation, and functional requirements of farm buildings. Soil and water engineering includes drainage, soil erosion control, irrigation, land clearing, and flood control. The power and machinery option follows the mechanical engineering design course closely, and the farm structures and soil and water engineering option includes civil engineering design. Courses are offered in the fourth major field in agricultural engineering—rural electrification. Included are electric service to rural areas, and the development and use of farm machinery and equipment involving electricity.

The agricultural engineering curriculum follows the common freshman engineering program of study in the first year. In the second year, the study program begins its specialization, and in the third year, the student chooses between one of the two options offered. The program of study is so arranged as to

Ag. Engineering Department

by Howie Hadler, ag. e. '54

give the student a thorough groundwork of basic engineering courses which are necessary in any engineering field, along with specialized courses necessary to the particular field and agriculture courses needed to give a thorough understanding of problems in agricultural engineering.

In addition to the four-year curriculum in agricultural engineering, the department also cooperates with the college of agriculture in a five-year plan leading to degrees both in agriculture and agricultural engineering. The department also offers many courses to students in the college of agriculture. Beginning in the fall of 1951, winter and short courses were offered, as were extramural graduate courses.

As a part of the Agricultural Experiment Station, the department carries on an extensive research program. Most of the staff members give all or a major part of their time to the research program.

The scope of the research program is varied, but is centered mainly in the four primary divisions of power and machinery, rural electrification, farm structures and housing and soil and water engineering. Part of the work is cooperative with other states in the North Central region; with the Department of Home Economics; and with the U. S. Department of Agriculture. The contract study is being handled for the U. S. Department of Agriculture Regional laboratory of Peoria. Several studies are supported by industrial organizations that provide about $25,000 a year for certain research projects.

In power and machinery research, the work includes study of tractor valves, use of alcohol-water injections, spray equipment, sunflower harvesting, and development of other machinery and equipment for more efficient operation. A 60-acre tract of farm land is operated in conjunction with the projects.

The principal rural electrification study is centered on the development of automatic equipment controls and the methods for feed handling, mixing, grinding, and distribution to livestock. Other work deals with ventilation, and building environment.

Farm structures and housing research emphasizes labor efficiency, production requirements, fire and wind loss prevention, utilization of materials and improved construction methods. Extensive work is done on farm housing, particularly to develop farmhouse plans and planning methods.

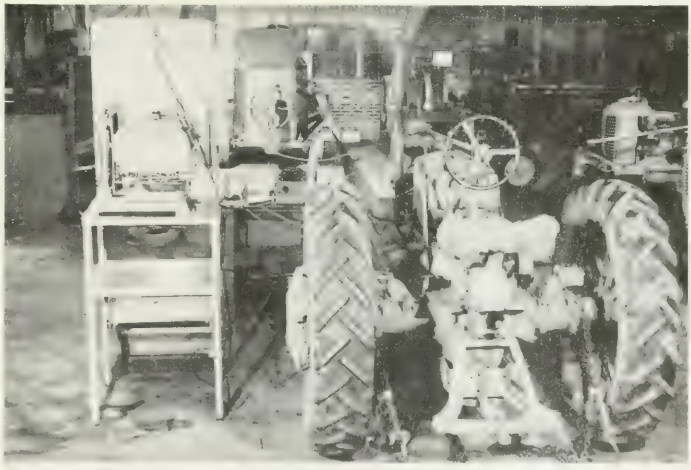
Soil and water engineering research covers such studies as drainage of plastic till soils, surface irrigation, water runoff, design of conservation structures, and surface water supplies.

Over the years, the department has pioneered in the study of problems that contribute much to engineering in agriculture. Some examples are initial work on hay crushers; studies in handling and storing soft corn; preliminary work on hay drying and crop conditioning; early installation of the high-compression head on farm tractors; experiments with the use of combines in the humid region.

The research program contributes much to the extension service of the department. The extension service of the agricultural engineering department is under the college of agriculture Extension Service. The extension service publishes many bulletins and circulars for information to farmers and others working in the field of agriculture. Much of the information for these bulletins is obtained from research projects and research investigation. The farm buildings branch of the department sells at cost an average of better than 1,000 farm building plans per month. Many of the plans are the result of research in farm building design.

Five men in the department give full time to the extension program with help from other staff members. The program is varied and includes all lines of subject matter with most emphasis given to demonstrations, county meetings, 4-H club projects, and short courses. The main purpose of the extension program is to supply the farmers with the most

(Continued on Page 22)



A view of the tractor laboratory showing a tractor ready to be tested on the dynamometer with other tractors and equipment in the background.

introducing . . .

by Tom Madden, m. e. '54, Oliver Smith, m. e. '54
and Lee Grossman, m. e. '53

EDWARD FORT

Edward Fort, a senior in mechanical engineering at the University of Illinois, graduated from Stonghurst High School. He started his professional training at the University of Cincinnati where he enrolled in a co-op plan which consisted of attending school and working on alternate semesters. Upon completion of his freshman year, Ed transferred to Illinois and enrolled in the mechanical engineering curriculum.

While here at Illinois he has been active in extracurricular activities and at the same time has attained an enviable scholastic record. Ed's main interest in mechanical engineering is in internal combustion engine testing and prime movers. He is working for Professor Hull in the M.E. Internal Combustion Laboratory as assistant, mechanic, and general helper. This actual

EDWARD FORT

work with the engines, he feels, is invaluable experience that will be of great use after graduation. Ed received the Scholarship Key for being in the upper three per cent of his class for the last four semesters, and also was initiated into Pi Tau Sigma—which he was president of last semester, Sigma Tau, and Tau Beta Pi engineering honoraries. Among extracurricular activities directly connected with the University, he was a demonstrator for the last I SEE and is publicity chairman for the 1952 Engineering Open House committee.

Ed has one hobby that stands out in importance over all of the rest and that is golf. In fact he is such an avid golfer that he arranges his class schedule so as to have two or three afternoons a week free to pace the greens.

Upon graduation he will receive a commission in the Navy to do engineering work as a naval officer. Just what type of work or where it will be is still a mystery to Ed. Job offers from private industry include a position testing fuels at the Ethyl Company.

The *Technograph* this month salutes Ed Fort, engineering student extraordinary, and wishes him the best of luck for a prosperous future.

DAVID HARRIS

Another of the amiable personalities in attendance at the undergraduate division of the University of Illinois is David Harris, better known to his friends as "Dave."

Of farmer parentage, Dave received most of his elementary education in a country school. When his folks retired and moved to Bardolph, Illinois (another "wide spot in the road") Dave transferred there to complete his grammar school education.

While in high school, Dave took an active part in extracurricular activities in the way of sports and student functions. Also, as in the case of many individuals living in farm areas, he participated in 4-H club functions and later joined the Future Farmers of America.

Not long after graduation from high school, Dave was sent on a free trip half way around the globe through the courtesy of Uncle Sam. During the 18 months in the Infantry, he saw service with the occupational forces in Korea prior to the communist invasion. Upon discharge he enrolled in the U. of I. and began his career.

Being another of those whose interests lies in the farming field, Dave entered the curriculum of agriculture. Attaining a high scholastic average he has since been admitted to the Tau Beta Pi honorary engineering fraternity.

A member of the American Society of Agricultural Engineers, this popular gentleman has served as secretary and vice president. He was elected to presidency last fall and is now serving in that capacity until he graduates in June. In addition to being president of the society he is also on the committee for the publication of the twentieth anniversary issue of the ASAE Annual.

Besides all his other activities, Dave still finds time to belong to Triangle fraternity.

While attending college, Dave has chosen summer work of a nature similar to his selected field. For the past two summers he has worked with the Federal Soil Conservation Service on some of their projects. This is partially the

DAVID HARRIS

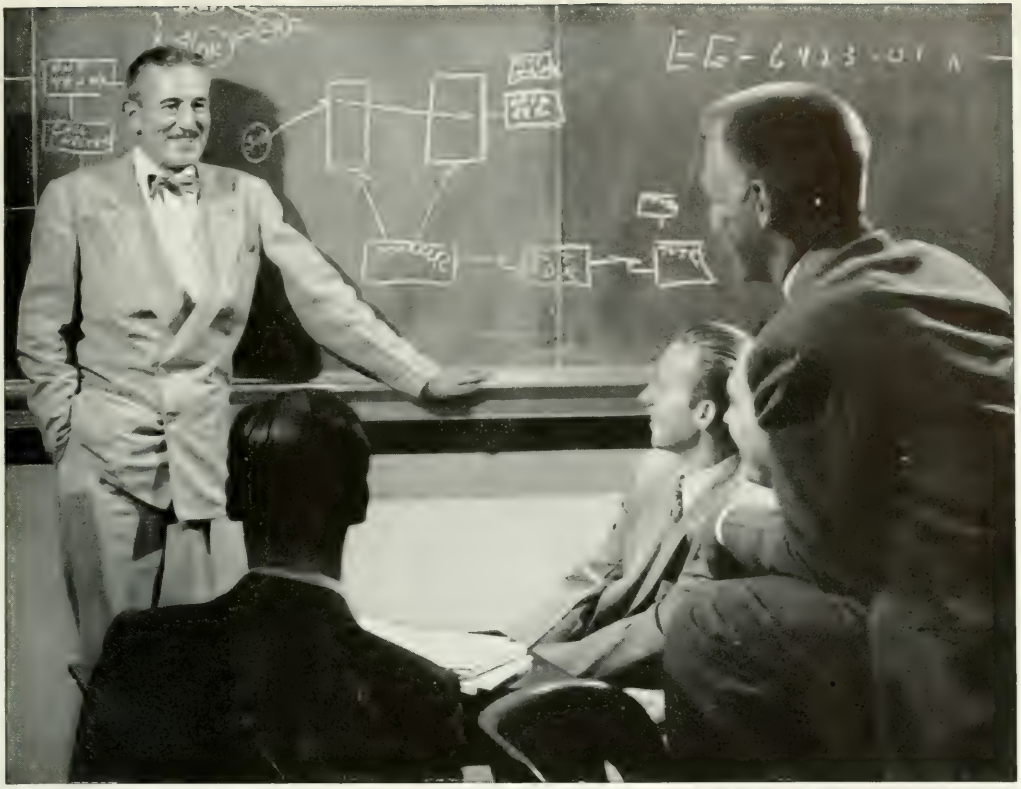
reason for his choice of soil and water conservation in addition to farm electrification for his options.

Dave has no positive plans for the future in the way of employment but thinks he might be attracted by one of the offers he will get during this (his last) semester. He hopes eventually to become a consulting engineer. One thing that is certain, which he related with no secrecy to this writer, is a sincere contemplation of marriage upon graduation.

HARRY P. BATEMAN

South of Green street and even further south than the Commerce and LAS campus, one is apt to find that

(*Continued on Page 24*)



In classes like this at the Bell Telephone Laboratories' school for communications development training, college graduates study electronics, oscillations and waves, switching and transmission.

THEY'RE HEADED FOR NEW FRONTIERS

Each year the Bell System selects hundreds of college graduates to learn how to develop, maintain and administer our country's telephone system. Thanks to the competence of our nation's professional educators, these graduates come with an excellent grounding in fundamentals.

Those specially fitted for research, work in the Bell Telephone Laboratories to develop tomorrow's telephone service. In the Western Electric Company, others are planning manufacturing processes or supervising production operations. And in the Bell operating companies, still others are engaged in the engineering and administrative side of telephone service.

More than ever, America's future must depend on men and women who are trained to think far ahead. They are needed both in technology and in administration.

By joining forces with such people, and helping them progress, the Bell System works to keep America's telephones the world's best, and to help the armed forces keep our country safe.

BELL TELEPHONE SYSTEM

interference-free TV reception with . . .

U H F - T V

by Ken Kolence, physics '53

It's the year 2000, and as you hand out the drinks, one of your guests looks at his watch and remarks, "Say, isn't it almost time for the Illinois-Michigan football game?" And indeed it is, so you turn on your television set, sit back, relax, and wait for your set to warm up. In a few seconds the picture springs into full focus—only it isn't exactly a picture, it's more like a little stage, reproduced in full color. And as we sit back, enjoying the football game on your modern three dimensional television screen, let us look back 50 years to the development that has made all this possible.

By 1948, it had become evident that overcrowding was becoming a serious problem in that portion of the radio spectrum used for standard TV broadcasting. This portion, known as Very High Frequency (VHF) only provides

This UHF-TV converter can be installed on all existing television sets. (Courtesy of RCA)

enough space for 12 regular channels within a given area. Thus, in order to provide for interference-free reception, the Federal Communications Commission froze the construction of all new VHF television stations until new spectrum space could be found for use by the rapidly growing television industry.

In late September of 1948, TV broadcasting represented a troublesome paradox. At that time, only 40 commercial stations were in operation, and they were all losing money. Yet, in certain heavily populated areas, all available channels had been filled, and the FCC had authorized construction of 84 new stations. In addition, there were 300 other applications still pending. Thus, at that time, the FCC held a hearing with the intent of exploring the possibilities of television in the Ultra High Frequency (UHF) range.

It was at this time that it was first brought out that the field strength required for UHF television would be 10 times that of the standard VHF field, with the coincident requirement for a tube capable of a power output much higher than any previous tube of this type. Consequently, the opinion resulting from this hearing was that it would be from one to three years before commercial UHF television would be feasible. However, it was disclosed that, in nearly all other respects, UHF range was equal to or superior to the VHF band for television. With this last result in mind, an intensive program of tests and experimentation was begun by the television industry in an attempt to perfect commercial UHF television.

To understand the difference between VHF and UHF, and to further understand the importance of UHF, it might be well to look for a moment at the radio spectrum, as designated by the Federal Communications Commission:

Very low frequencies	10 to 30 kilocycles
Low frequencies	30 to 300 kilocycles
Medium frequencies	300 to 3,000 kilocycles
High frequencies	3 to 30 megacycles
Very high frequencies	30 to 300 megacycles
Ultra high frequencies	300 to 3,000 megacycles
Super high frequencies	3,000 to 30,000 megacycles

In terms of actual wave length, the higher the frequency, the shorter the waves. Thus, in the medium frequencies, which are used for transoceanic wireless service, the radio waves are up to 10 miles in length. In contrast, the wave length of television channel 2 in the VHF band is just under 18 *ft.*, channel 12 about 4½ *ft.* and in the UHF band, the wavelengths vary from 2 *ft* down to 13 *in.*

At a point just below the VHF band, extremely long distance communication is possible, but in the VHF band itself the limit of communication becomes the horizon as seen from the top of the antenna tower. The cause of this is in the strange actions of the ionosphere, which lies about 200 miles above the earth's surface. The ionosphere plays a big role in long distance short wave broadcasting, for they are

KEN KOLENCE

Ken, a junior in LAS physics, hails from Waukegan, Illinois. Graduating from Waukegan Township high school, he originally enrolled at Lake Forest College before coming to Illinois.

At the present time, Ken is busy working on the physics exhibit for the 1952 Open House. He is also scholarship chairman of Chi Psi social fraternity and a member of Phi Eta Sigma, freshman honorary fraternity.

reflected back to the earth's surface—thousands of miles from their origin—by this layer. Waves in the VHF band and higher, on the other hand, are so short that they pass right through the ionosphere. Thus, as far as the engineers are concerned, the only important waves transmitted via VHF or UHF are those that travel in a straight line. This is why the range of the telecast is limited, being dependent upon the height of the antenna tower as well as the power of the transmitter.

But despite these limitations, the higher frequency bands provide us with the only practical means of broadcasting TV. The answer to this seeming paradox can be found in the fact that, in the layman's sense of the word, television is a big user of spectrum space. An ordinary black and white television channel requires six megacycles of the radio spectrum. This is actually more than the first three divisions of the radio spectrum combined, and it would appear at first glance that each channel represents a major portion of the spec-

(*Continued on Page 28*)

5 a.m.

A bottle of milk is the last scene in the last act of the cow-to-cup drama.

The real stars in this drama are milking machines, pasteurizers, bottle washers, homogenizers, and delivery trucks. Synthane—a laminated plastic—plays an unseen but essential part in these and other kinds of electrical and mechanical dairy equipment.

The dairy industry appreciates, as you may, the fact that Synthane is strong, light in weight, chemical-resistant, easily machined, and a good electrical insulator—all rolled into one. And that it is available in sheets, rods, tubes, and fabricated parts.

Try Synthane laminated plastics yourself. There is an interesting 26-page catalog of its properties and possibilities waiting for you. Synthane Corporation, 1 River Road, Oaks, Pennsylvania.

AIRCRAFT electronics system part, made from Grade LE Synthane. Application requires good electrical properties, resistance to moisture, retention of size and shape at elevated temperatures.

Synthane—one of industry's unseen essentials

SYNTHANE

LAMINATED PLASTICS

skimming industrial headlines

edited by Howie Hadler, ag.e. '54

radiation-detection devices

The atomic age requires special instruments. Already several types of radiation-detection (radiac) devices have appeared as a result of both the peaceful and military aspects of nuclear energy. Two portable types, each completely self-contained and weighing about 11 *lb*, are being developed for the Army and the Navy. One employs the ionization principle, as distinguished from the familiar Geiger counter. This type of radiac gives a true measure of Roentgen energy from 0.08 to 2.0 million electron volts over the entire spectrum, which the Geiger counter cannot do. The new instrument has the extraordinary range of six decades, from 0.005 Roentgens per hour to 500 Roentgens per hour, which latter extreme intensity might follow an atom bomb disaster. The readings are provided as indications on a special change-scale instrument, not as clicks heard in earphones. Although the range is extremely broad, the accuracy is as good at the low settings as the higher ones. The electrometer principle employed has a longer time constant than other principles, which means the indications are not quite as rapid.

The other portable radiac employs a newer principle—developed by Westinghouse—that of photoelectric detection and multiplication of the light given off by phosphorus struck by the nuclear radiation. It is a little faster in response than the ionization-chamber type, very easy to use, and its warm-up time is less but it is not as sensitive. It is direct reading too, but only for the four higher ranges—from 0.5 to 500 R per hour.

In great contrast to these one-man, portable radiacs is a system of radiation detection for an area in which several detectors transmit signals to a central point where they are separately indicated, totalized, and running record made on tape.

Another type of radiac still undergoing development is a compact unit for instaliation in military planes. It will give the pilot a visual indication of danger should his plane enter a zone of strong radiation.

underground tank

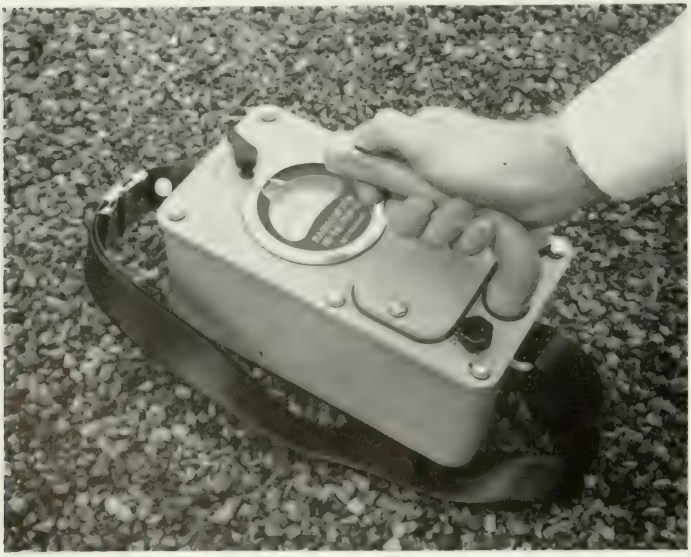
A new vehicle which operates like an Army tank has been developed by G-E for use in shuttling coal from veins to coal cars far beneath the earth's surface.

Equipped with treads similar to those on an Army tank, but having a much lower silhouette, the "shuttle car" is powered electrically, and its "extension cord" or power cable is plugged into an outlet in the same way household appliances are. The 600 *ft* of cable are automatically reeled in or out as the car travels.

Coal is first loaded on the car deep in a vein by miners or by automatic mining machines. Then the car carries its load to the main tunnel and transfers it to small railroad cars or belt conveyors which then take the coal to the hoists or to the surface.

The car has a snout, which it can raise or lower, from which it disgorges its load by means of a continuous conveyor belt.

Because of its treads, the new vehicle can turn in a tight circle simply by locking one track and going ahead on the other. The treads also enable the car to carry a larger load than the conventional type equipped with wheels. Clearance pockets for the tires on conventional type shuttle cars cut down coal capacity. In addition, the wider conveyor belt made possible by the elimination of wheels, results in faster unloading. The vehicle can carry up to 10 tons of coal. It is about 22 *ft* long, 8 *ft* wide, and 3 to 4 *ft* high, and is built for either left or right-hand drive.



This newly developed radiation detector is completely self-contained and can be easily handled by one man. (Courtesy of Westinghouse)

new searchlights

The 24-*in* carbon-arc searchlight, as is standard equipment on some of the Navy's vessels, has been considered a well-developed, tried-and-tested device for many years. However, nine years ago development began on an improved model that is now superior to any previous model. The beam candlepower of the newly developed searchlight is 50 million as compared with 26 million beam candlepower of the older models. And all this is done with current input increased only from 70 to 105 amperes.

Part of the gain in output comes from improved carbons developed by the National Carbon Company. Also, an arc structure in which the carbons burn at almost a 90° angle, instead of the former 16° or 23°, enables it to keep out of its own light; the area of the mirror obscured by the arc mechanism has been cut from over 20 per cent to less than 5 per cent.

An entirely new control maintains a

(*Continued on Page 28*)

Acetylene still shows the way

Your nicest textiles—as well as vitamins, headache remedies, plastic garden hose, or welding on your car—may stem from this versatile gas

FORTY YEARS AGO acetylene gas made from calcium carbide was used for home and street lighting, and was in common use for bicycle and automobile lights. Though these old lights have long since gone out, acetylene has gone on to chemical greatness.

IN CHEMICALS—Today, acetylene is the parent of hundreds of chemicals and chemical products used to make plastics, insect sprays, vitamins, aspirin, sulfa drugs and many other things.

Acetylene is the source of some of the basic chemicals in *dynel*, the new wonder textile fiber. It also goes into the Vinylite plastics used in beautiful home furnishing materials, protective coatings, and a host of other products.

IN METAL FORMING—In the production and use of metals, acetylene teamed up with oxygen has revolutionized many industries. From mines-to-mills-to-manufacturer, you will find oxy-acetylene cutting, welding and metal conditioning.

50 YEARS OF PROGRESS—The people of Union Carbide have produced acetylene for over half a century. Through continuous research they have made many remarkable acetylene discoveries important in the lives of all of us.

STUDENTS and STUDENT ADVISERS

Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of U.C.C. in the fields of Alloys, Carbons, Chemicals, Gases, and Plastics. *Ask for booklet O-2.*

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UCC's Trade-marked Products of Alloys, Carbons, Chemicals, Gases, and Plastics include

Prest-O-Lite Acetylene • Linde Oxygen • Prestone and Trek Anti-Freezes • Bakelite, Krene, and Vinylite Plastics • Synthetic Organic Chemicals
National Carbons • Acheson Electrodes • Pyrofax Gas • Haynes Stellite Alloys • Electromet Alloys and Metals • Eveready Flashlights and Batteries

by Bob Schrader, ch.e. '54

The president of the New York State Society of Professional Engineers, H. Gregory Shea, has gone on record as saying that more efficient use of engineers in industry and public projects could increase their availability for engineering tasks as much as 50 per cent.

In analyzing the current nationwide shortages of engineers, Mr. Shea stated that existing practices of engineering and manufacturing concerns and public organizations aggravate the scarcity of engineers.

More efficient use of engineers would justify higher pay rates, according to Mr. Shea, thus attracting back to engineering operations many of the thousands of graduates who have left the field to become salesmen, or to enter other fields where rewards seemed greater.

In describing common examples of inefficient methods, Mr. Shea pointed out the waste of time in such varied duties as answering telephones in engineering offices, writing reports which have to be written longhand when they might more readily be dictated, and in handling of catalogue files and making reference searches. By more extensive use of nonprofessional assistants for such work, the same duties could be accomplished with limited supervision. Many professional engineers now spend from 50 to 90 per cent of their time doing clerical work instead of engineering tasks. By concentrating clerical work with secretaries and office boys the productivity of engineers would be increased.

Mr. Shea claims that the fully trained engineer should do only engineering thinking, directing, inspection, and conference work. By adding non-engineering personnel to do minor tasks, two engineers could do the work for which four are needed now.

As an aid to new students who are sometimes confused by campus terminology we hereby present the following one-third column dictionary.

Slide rule—an instrument slightly resembling a 12 *in* ruler which is used primarily for back-scratching and mosquito swatting. On the slide rule are a confusing jumble of letters and figures. These are used purely for decorative purposes. The slide rule also has a movable centerpiece which facilitates its use as a pool cue.

File—a hardened steel instrument having cutting edges, or teeth. No other meaning or connotation of this word is tolerated on campus.

Textbook—a thick, heavy object carried to class by the engineer in order to strengthen his arm muscles. The price of text books at current exchange rates is about $1.99 per pound.

The Practical Engineer
(*The first of a series*)

Kam's, Bidwell's, Katsina's—names of laboratories for the study of fluid flow.

Buried in the back page of one of last year's *Technograph* was a short paragraph on a slide rule contest at Texas A&M. The Aggies ran their contest something like this.

Every engineering freshman must take an engineering problems course. The top 10 per cent of the students in this course are selected to compete in the annual slide rule contest. At the contest each participant is given 60 problems to do in 50 minutes. The problems are generally somewhat like this one:

$$Y = \frac{(\tan 30)^2 \sin 41}{\sqrt{131}\ (\cos 14)}$$

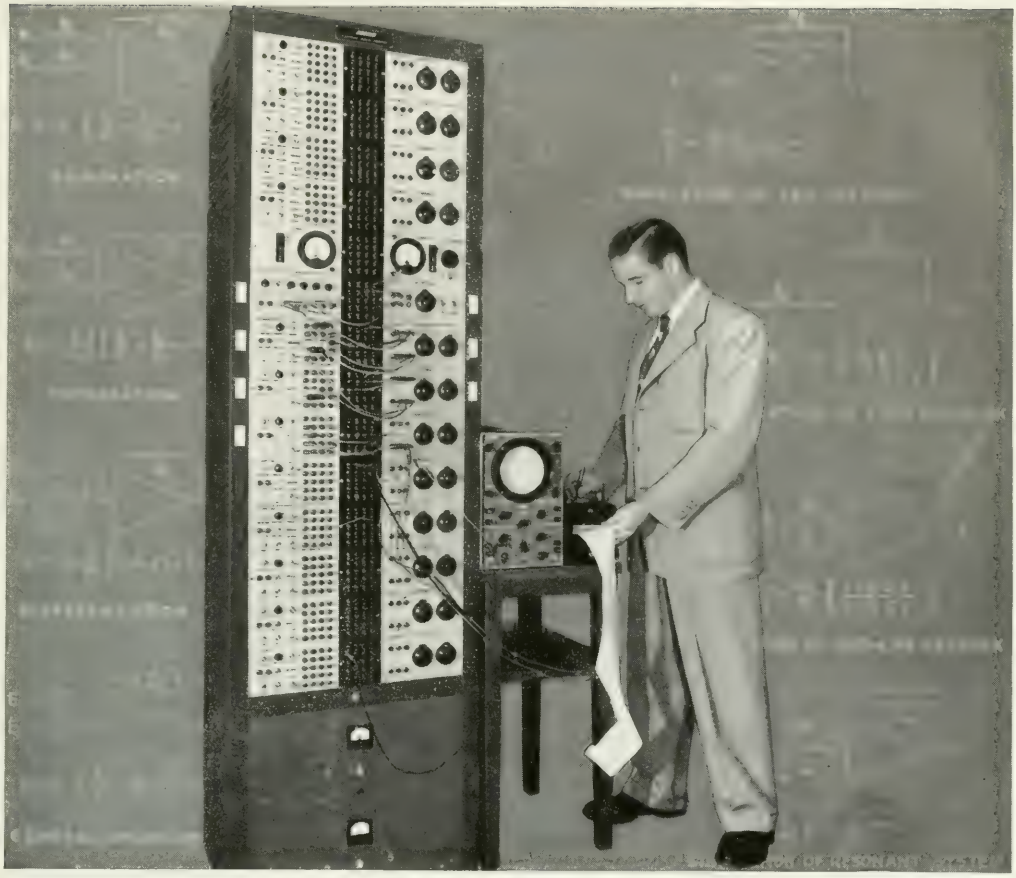
Both speed and accuracy are taken into account, so the winner is the man who gets the most problems right in the time allotted.

A contest like this would possibly work very well at the U. of I. It could be worked through Engineering 100 for freshmen, or sophomores could be included by making the contest available in some course which all sophomores take, such as Physics 103.

A slide rule contest would benefit engineering at Illinois in two main ways. First of all, it would stimulate freshman and sophomores to become proficient in using a slide rule. As it stands now, many freshmen and sophomores in engineering are complete strangers to the slide rule. Secondly, it would tend to promote *esprit de corps* in the engineering college. A slide rule contest may possibly prove impractical in the long run, but as of right now it seems like a good idea.

A rather cocky Sunday golfer looked toward the next green, waggled his driver confidently and declared. "That's good for one long drive and a putt." He gave his club a mighty swing, blasted up about two inches of sod, and managed to get the ball about three feet from the tee.

The caddy stepped forward, handed him the putter and suggested, "Now for one hellova putt."



Solving a dynamics problem with the Boeing Computer; oscilloscope at right shows result.

What's it like to be a Boeing engineer?

Boeing engineers enjoy many advantages – among them the finest research facilities in the industry. These include such advanced aids as the Boeing-designed, Boeing-built Electronic Analog Computer shown in the picture above.

This is part of the stimulating background that helps Boeing men maintain the leadership and prestige of an Engineering Division that's been growing steadily for 35 years.

If you measure up to Boeing standards, you can share that prestige. And you'll work with renowned engineers on such vital projects as guided missiles, the still-classified B-52, the record-shattering six-jet B-47, and other outstanding developments.

You can work in Seattle, in the Pacific Northwest, or in Wichita, Kansas. You will benefit from in-plant training programs, from merit reviews that enhance advancement opportunities. You'll be part of a distinguished, long-range Engineering Division. You'll be proud to say, "I'm a *Boeing* engineer!"

So plan *now* to build your career at Boeing after graduation. Salaries are good, and they grow as you grow. Boeing has present and future openings for experienced and junior engineers for aircraft

- ***Design***
- ***Research***
- ***Development***
- ***Production***

also for servo-mechanism and electronics designers and analysts and for physicists and mathematicians with advanced degrees.

For further information,
consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer – Personnel
Boeing Airplane Company, Seattle 14, Washington

BOEING

VOCATIONS . . .

(*Continued from Page 7*)

However, three utilities have found it desirable to have ten or more. A score of the hundreds of farm electric co-operatives have found it profitable to use agricultural engineers to manage or assist in managing their operations.

One of the proven opportunities for an agricultural engineer is to get started in a substantial small business of his own, or to work into a partnership, in the distribution of farm equipment, building materials, and related items. Somewhere around one hundred ASAE members are owners, partners or employees in this type of business, and doing well at it. This is just enough to emphasize the need and opportunity for agricultural engineers in thousands of similar establishments.

Other lines of work and types of employment in private enterprise in which individual ASAE members have been successful, and have proven the value of their engineering training, add to the variety of opportunities for new employment and progress. They include farming, agricultural engineering work for large farms and for processors of farm products, management of individual farms, and of groups of farms on a consulting basis, consulting work on agriculture and engineering, the farm and trade press, trade associations, farm organizations, general contracting, and farm work and soil conservation contracting.

In public service, agricultural engineers are employed in a variety of agencies in addition to those directly concerned with teaching, extension, and research. Two ASAE members are employed by the United Nations.

In the federal government there are ASAE members employed in the Bureau of Public Roads and Bureau of the Census of the Department of Commerce; in the Geological Survey, and Bureau of Indian Affairs as well as the Bureau of Reclamation, Department of the Interior; in the State Department Institute of Inter-American Affairs; in the land, sea, and air branches of the Department of Defense; and in the Federal Land Banks, Public Health Service, Veterans' Administration, Federal Power Commission, Office of Education, and War Production Board. In addition to those in the Department of Agriculture, ASAE members are employed by the Farm Security Administration, Forest Products Laboratory, Office of Foreign Agricultural Relations, Office of Personnel, Weather Bureau, Regional Research Laboratories, and Farm Credit Administration, in addition to those in SCS, BPISAE, Extension Service, and the Office of Experiment Stations.

Among extra-governmental activities, the TVA is an established employer of agricultural engineers, and the Lower Colorado River Authority has already employed at least one.

In some of the states and territories, agricultural engineers are employed in agencies concerned with natural resources and with public health, and in state schools, as well as in the land-grant colleges and experiment stations and the extension service.

In still more localized public service, agricultural engineers are employed by some county engineering departments and by irrigation, drainage, and soil conservation districts. It appears that these agencies may justify and develop a considerably increased demand for agricultural engineering services. In Canada, the dominion government and the provinces employ agricultural engineers on a comparable basis in proportion to the extent of their agriculture.

On other continents, demand for agricultural engineering services has shown up in civilizations as old as those of China and Egypt; in governments as new as those of Israel, India, and Pakistan; and in regions as undeveloped as the Amazon River Valley.

The capacities in which ASAE members are employed range from trainees to presidents and chairmen of the boards of large corporations, corresponding high administrative posts in public service, and ownership of businesses of various sizes.

It seems to us that the basis of all this present and potential opportunity for agricultural engineers lies in a very significant fact. It is impossible to give intelligent consideration to any major phase, aspect, problem, or operation of agriculture without including consideration of its related physical factor. These physical factors—the environment of men, animals, and crops; the energies, dimensions, and operations involved; the very physical structure and properties of biologic materials—are the field in which engineering has proven the most effective technology and agricultural engineering the most effective specialization of that technology on behalf of agriculture. Opportunities for agricultural engineers will increase as recognition of the fact becomes widespread, and as agricultural engineers continue to add to their established record of service.

One of the jobs of the agricultural engineer is the conservation of the world's largest and most valuable known resource. Unlike our other known resources, such as coal, oil, minerals, and metals, the earth's cover of soil can be reused again and again, providing it is managed under proper care. From the soil comes all plant food and materials upon which all animal life is dependent. The value of soil as a resource cannot be estimated in units of earthly exchange, as it is the key to life itself. Agricultural engineers thus shoulder a tremendous responsibility in serving agriculture and all mankind. A shortsighted or selfish outlook can bring ruin and chaos. The social and moral code of an agricultural engineer therefore must be and is of the highest order.

The basic job of the agricultural engineer is to keep agricultural production abreast and in tune with the increasing and changing demands of the world without impairing or destroying its life-giving potentiality. Within a few decades we have advanced from human and animal power to mechanized power. As a result of our changing society, labor and raw materials have become the key to production and prosperity. The farmer thus finds human power too expensive and animal power too efficient. The present stage of development finds the mechanization of the basic production of agriculture well under way.

Today, in the United States, the largest population in our history is being supplied with the fundamental agricultural necessities of life by the smallest per cent of the nation's productive workers. Whereas, 150 years ago nine out of ten people followed agricultural pursuits and were required to keep the agricultural supply up with the demand for agricultural products. Today, one farm worker is able to feed and supply ten people and thus free them for work outside of agriculture. This great change has resulted in a diversified and rich national economy and has been made possible only by the application of engineering principles to the science of agriculture.

With the help of the agricultural engineer, the foundation of a civilization has been established which no longer tolerates the drudgery and burdens of an agricultural people. New farming practices and ingenius machines have enabled the tiller of the soil to enjoy a new standard of living. From a bare existence embodying hard work, long hours, illiteracy, and poverty, the farmer has progressed to his rightful place as a prosperous and educated citizen. The alert farmer of today is no longer bound by custom and habit. He can apply his own skill and talents to adopt and modify his farming program to make better use of the practices and tools available to him. The agricultural engineer has thus helped to release a new power, the power of a free and thinking agricultural people.

Agricultural engineers are today counsel to billions of dollars. Agriculture is definitely big business, with an average annual income of approximately sixteen billion, depending upon the yields and prices which may cause it

(*Continued on Page 30*)

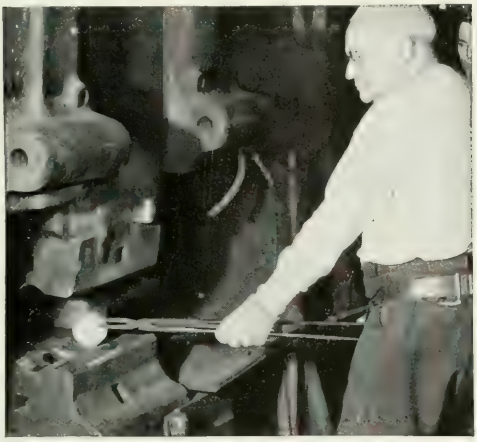
What's Happening at CRUCIBLE

about tool steel forgings

Whether 1½ pounds or 7 tons . . . forgings get the same sensitive handling

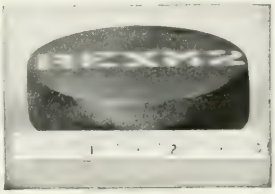
Crucible's reputation as the specialty steel leader is built on a devotion to the smallest detail . . . regardless of the size of the order.

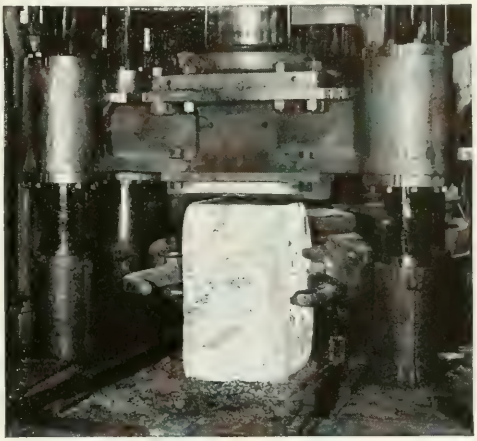
These forgings are good examples of Crucible specialists at work:

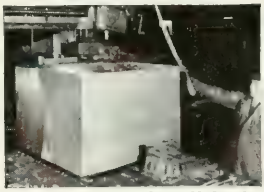


Rex M-2 High Speed Steel Disc Forging (1½ pounds)

Pancake forgings such as these are used extensively by small tool makers. Extreme care is taken in the preparation of the slug stock. The upsetting insures proper flow lines. Milling cutters, gear shavers and similar cutting tools that require maximum toughness, coupled with the best cutting ability, are made from these forgings.







CSM-2 Plastic Mold Forging (14,000 pounds)

This CSM-2 plastic mold steel forging was made from a 25,000-pound ingot. This block will be heat-treated and worked to produce a mold for the manufacture of large plastic parts. The finished weight of the forging is 14,000 pounds. And it is the largest mold forging yet produced by Crucible.

Engineering service available

Crucible's engineering service is geared to meet your research and development problems. If you use special forgings, or any special purpose steel, check with Crucible. Crucible Steel Company of America. General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

52 years of Fine steelmaking

Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

AG. ENGINEERING . . .

Continued from Page 9

information on the application of engineering to a farming program.

The students of the department maintain an active local chapter of the student branch of the American Society of Agricultural Engineers. Each year the students in the department publish an annual which contains articles about the department and is used to keep alumni in touch with happenings in the department. Another purpose of the annual is to familiarize high school students with the department.

Students in the department take an active part in the Engineering Council and participate in the Engineering Open House activities and the St. Pat's Ball.

Students frequently ask themselves, "What careers will be open for me when I finish school?" Agricultural engineering has many career opportunities. The demand for agricultural engineers far outnumbers the available supply. The needs for engineers will not be met within the next five years. The majority of graduates choose engineering with industrial organizations, mostly with manufacturers of machinery and power equipment. There is a strong demand for men to fill positions in colleges and experiment stations for teaching and research. Government job outlets include the Soil Conservation Service, the State Soil Conservation Districts, and the U. S. Bureau of Reclamation. Recently a number of agricultural engineers have been employed as power-use advisers by electric companies. A few graduates are now in foreign service. Foreign opportunities range from export work to sales work. As an example, one U. of I. graduate is an assistant to the director of conservation in Israel. Nearly one-fourth of the graduates have continued with advanced work. Farming attracts a large number of graduates, both in operation of farms and as members of management organizations, seed companies, feed companies, and cooperatives.

Records on 115 graduates (not including the 1951 class) show that 49 are in engineering work with industrial organizations, 35 are in public service work with federal or state government agencies, 21 are in private business, either farming or commercial work, and 10 are in various occupations not known or unclassified.

About 45 per cent of all graduates are in power and machinery work, 18 per cent are in soil and water engineering, 14 per cent are in structures work, 17 per cent are in electrification and the other 16 per cent are unclassified.

Employers of agricultural engineers give a great deal of weight to farm background. Therefore, anyone interested in engineering who has had a farm background and a genuine interest in agriculture as well as engineering should certainly consider agricultural engineering as a possible profession.

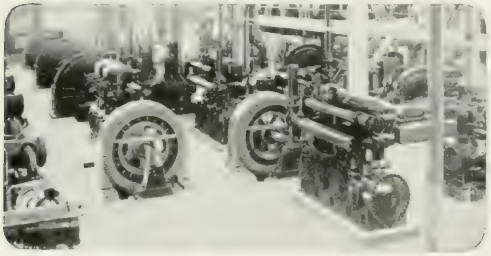
Two glamour girls boarded a crowded street car, and one of them whispered to the other, "Watch me embarrass a seat from one of the men."

Pushing her way through the standees, she bore down on a gentleman who looked substantial and embarrassable.

"My deah Mr. Brown," she gushed, "fancy meeting you on the car. Am I glad to see you—you're getting to be almost a stranger. Oh, am I tired!"

The sedate gent looked up at the girl he'd never seen before, and, as he rose, he said for all to hear: "Sit down, Bertha, my girl, we don't often see you out on wash day. No wonder you're tired. By the way, don't deliver the washing till Wednesday. My wife's going to the district attorney's office to see if she can get your husband out of jail."

A Scotsman was leaving for a business trip, and as he departed he called back, "Goodbye all, and dinna forget to take off little Donald's glasses when he isn't looking at anything."



Celanese Corp. Uses 6420 Horsepower of Frick Refrigeration

Fourteen Frick refrigerating machines are in operation at the Amcelle plant of Celanese Corporation of America, near Cumberland, Md., makers of chemical yarns. Most of these ammonia compressors have been in use since 1929. The motors driving the new vertical machines, shown in the foreground, are each of 1250 hp.

This is a large-scale example of the dependability and economy of Frick ammonia refrigeration. Power requirements, when operating in summer weather on air conditioning loads, are only 0.70 hp. per ton of refrigeration.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA. U.S.A.

Books and Supplies

for every engineering need

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ON THE CAMPUS

Television joins the microscope in a major scientific advance, pioneered at the David Sarnoff Research Center of RCA, Princeton, N. J.

Microbes star on Television

in war against disease!

Until recently, scientists found it difficult to keep microbes alive for study—at high magnification—in light microscopes. Dyes, used to make them visible, killed some. Others were destroyed by the intense light.

RCA scientists have solved this problem by making television a working partner of the microscope. "Eye" of their new system is a tiny industrial television camera built around RCA's sensitive *vidicon* television tube. No intense light is needed, since this electron tube "sees" at extremely low light levels. And by making the tube sensitive to the red or violet bands of the spectrum, dyes and stains are eliminated.

With RCA's system, research men can watch living germs or cells—immensely magnified—on the screen of a television set. Many are able to watch at a time. Students can be more easily trained. And science *learns more* about disease by watching *live* micro-organisms.

Improving the microscope by teaming it with television is an example of the many paths explored by RCA Research. You benefit directly by better performance from any instrument or service of RCA or RCA Victor.

* * *

See the latest in radio, television, and electronics at RCA Exhibition Hall, 36 West 49th Street, N. Y. Admission is free. Radio Corporation of America, RCA Building, New York 20, N. Y.

CONTINUE YOUR EDUCATION WITH PAY—AT RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey. **Also many opportunities for Mechanical and Chemical Engineers and Physicists.**

RADIO CORPORATION OF AMERICA

World leader in radio—first in television

RCA

INTRODUCING . . .

Continued from Page 101

particularly rugged breed of engineer known as the agricultural engineer. Here are one might call the foremen and the pioneers in the field of agricultural engineering who today create the pattern for our modern agricultural engineering curriculum. These men might be found at any time either conducting experiments for research projects or lecturing to a group of students.

One such pioneer in the field of agricultural engineering is Harry P. Bateman. Mr. Bateman started high school in Mansfield, Illinois, but after a year his family moved to Urbana. Here, at the Urbana high school, he completed his high school education.

Graduating from high school, he entered the University of Illinois agricultural school, which he graduated from in 1932. At this time a relatively new field had opened. It was called farm mechanics and was the forerunner of what we call agricultural engineering. Because of a scarcity of jobs in the field of agriculture, Mr. Bateman chose to return to school to study this new curriculum. In 1934, Mr. Bateman graduated in what was the first class to graduate in agricultural engineering from the University of Illinois.

After graduation he worked for two years with the soil conservation department at Macomb and Rushville. In 1936 he came back to Illinois to do research on power machinery of the farm which, at the time, was just coming into its own. In conjunction with farm machinery he worked with farmers in research on maintaining the efficiency of tractors. Another item that Mr. Bateman worked on was an attachment for combines which would enable them to harvest sunflowers. Sunflowers, it was found, have a very high grade of oil. The attachment was developed, but sunflower production proved uneconomical.

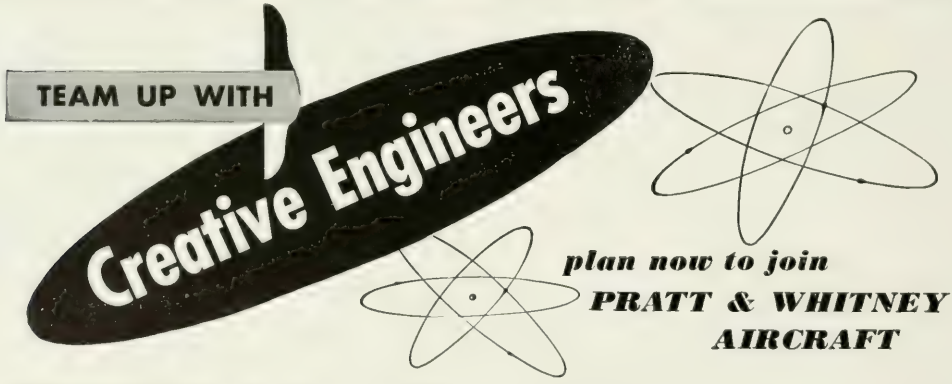
HARRY P. BATEMAN

For the past two years Mr. Bateman has been working at the new agricultural engineering experiment field where work has been done on corn planting and harvesting, corn shelling with a combine, an adjustable corn picker, and a mulch planter. In 1948, Mr. Bateman received his master's degree. At the present time he is doing full time research. During the war, however, he taught courses in Army personnel and diesel engines for the Navy, here at the University of Illinois. Mr. Bateman has even taught GED 101.

Mr. Bateman's hobby is photography. He is an avid amateur photographer with his own dark room. He likes to do color work and combines his hobby with vacation trips.

The teacher had forbidden all of the pupils from eating candy and chewing gum in class. One day she became quite suspicious when she saw a large lump in Jimmie's cheek. "Jimmie, are you chewing gum or eating candy?" she asked.

"Nah," replied Jimmie. "I'm just soaking up a prune to eat at recess."



For over a quarter of a century the Pratt & Whitney Aircraft Division of United Aircraft Corporation has depended upon *creative engineering* to bring its products to the forefront.

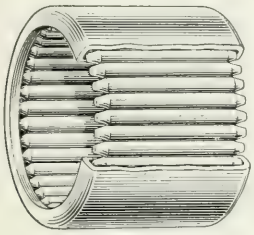
How well this idea has worked is amply demonstrated by the outstanding leadership record which Pratt & Whitney has established in both piston and turbine aircraft engine types.

And for the future, because of its sound engineering background and research facilities, Pratt & Whitney is one of the few companies in the country to be selected to develop an atomic powered engine for aircraft.

Creative engineering will continue to be given top emphasis at Pratt & Whitney—and it might well be the best answer to *your* future too—if you want a chance to put *your own* ideas to work.

Why not find out where you could fit into this great engineering organization? Consult your Placement Counselor or write to Frank W. Powers, Engineering Department at

The Torrington Needle Bearing is designed for high radial loads



The many lineal inches of contact provided by the larger number of small diameter rollers give the Torrington Needle Bearing an unusually high load rating. In fact, a Needle Bearing has greater radial capacity in relation to its outside diameter than any other type of anti-friction bearing. This is illustrated in the table below, which compares the dimensions of three bearings with identically rated radial load capacities.

	O. D.	I. D.	Axial Length
Torrington Needle Bearing No. B-1616	1¼"	1"	1"
Ball Bearing No. 405	3.15"	.98"	.83"
Bronze Bushing 3 sq. in area of bearing surface	1⅞"	1½"	2"

Dimensions for three types of bearings, all having the same rated radial load capacity.

Precision Manufacture and Unique Design

The exceptional load capacity of the Needle Bearing is the result of proper selection of steels, precision workmanship to close tolerances, and the application of modern anti-friction principles.

The one-piece shell, which serves as the outer raceway and retains the rollers, is accurately drawn from carefully selected strip steel. After forming, it is carburized and hardened. There is no further grinding or other operation that might destroy the wear-resistant raceway surfaces. The full complement of thru-hardened, precision-ground rollers is retained by the turned-in lips of the one-piece shell.

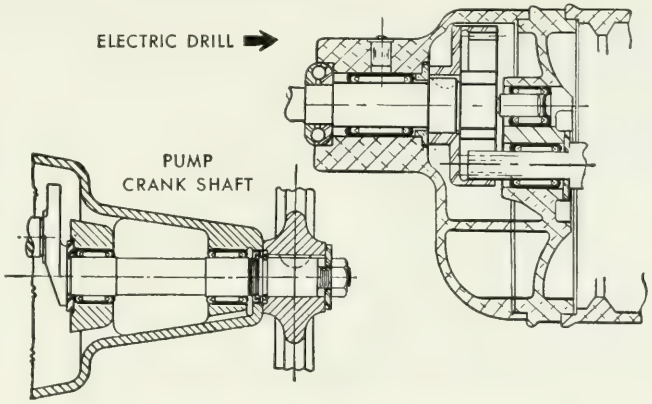
As the shaft is intended to serve as the inner race in most applications, it is hardened and ground to correct size. If an unhardened shaft is desirable, inner races can be furnished with the proper hardness.

Plus Features For Modern Design

The unit design and compact size of the Torrington Needle Bearing provide other, related advantages which are being utilized in more and more applications.

The outer shell is easily seated by press fit into a straight bore housing, machined to the proper dimensions. No complex housing structures are needed — no spacers, retainers or snap rings required. And the compact size and light weight of the bearing itself also help make the end product lighter and less bulky.

Wherever high radial load capacity is vital, but space and weight are at a premium, Torrington Needle Bearings provide an ideal solution.



High radial load capacity is vital in many bearing applications.

Future advertisements in this series will discuss other specific advantages of Needle Bearings. If you would like further information on these or any other type of anti-friction bearings, our engineering department will be glad to be of assistance.

THE TORRINGTON COMPANY

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TORRINGTON *NEEDLE* **BEARINGS**

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS

UHFTV . . .

(*Continued from Page 12*)

here. However, the trick in the real answer can be seen by considering for a moment the ordinary octaves used in the musical scale. The musical note "A," for instance, on the piano, has frequencies of 27.5, 55, 110, 220, 440, 880, 1760, and 3520 vibrations per second. Now each octave is defined as the difference between successive "A's," and as you can see, the last octave contains a

A mobile unit was used for checking UHF telecasts from the experimental station. (Courtesy of RCA)

wider range of frequencies than the entire six previous octaves. An entirely analagous definition holds for the radio spectrum. Thus only the higher octaves of the radio spectrum contain the necessary band width to support the tremendous amount of information which is broadcast by television stations. As a consequence, television occupies a total VHF band width of approximately the same fraction of an octave as it will in the UHF band, but UHF supports 70 television channels against 12 for VHF.

UHF, then, is destined to become the major band for telecasting. It will permit nationwide coverage by over 2,000 television stations, permitting cities of 50,000 and less to operate their own UHF stations. In addition, the tremendous band width available in this portion of the spectrum will permit broadcasting of much larger amounts of information than was hitherto possible. Color television, which ordinarily requires about a 10 megacycle band width, has been crowded into a 6 megacycle band by the ingenious methods of RCA scientists. But, for example, if three-dimensional television ever comes along, the amount of information which will have to be broadcast will be so large that these channels will have to be located even higher in the radio spectrum. Thus, development of the UHF band is a necessary step upward in the development and refinement of television broadcasting.

It was the Radio Corporation of America, in cooperation with the National Broadcasting Company, that first took the lead in the development of the UHF band for television. In the course of several years previous to 1948, manufacturers of television equipment had been conducting tests and experiments designed to further their knowledge about UHF television. Just previous to the FCC hearing in September of that year, RCA completed an extensive field test in Washington, D.C. At that time, it was decided by RCA that the only way in which to answer all the questions about UHF was to build and operate America's first ultra high frequency television station.

Bridgeport, Connecticut was chosen as the site of this station because of its location in the fringe area of reception between the New York and New Haven television stations, and because the hilly countryside provided an excellent opportunity to study the problems of transmission over unfavorable terrain. The actual location of the station is on "Success Hill," a rise of land 200 *ft* above sea level and two miles northeast of the center of Bridgeport. After the 1948 FCC hearing, preliminary details were quickly settled, and the project moved ahead rapidly. The transmitter building was completed on November 15, 1949, and a 40 *ft*. specially designed antenna was placed atop a 210 *ft* tower. Station equipment was designed by RCA and installed and operated by NBC under the call letters of KC2XAK, on 530 megacycles. The entire Bridgeport field experiment was arranged and supervised by Dr. C. B. Jolliffe, vice president and technical director of RCA.

This experimental station began broadcasting on Dec. 30, 1949, as the first and only VHF station to operate on a daily programming schedule. No actual programs originate from station KC2XAK. Instead, it is provided with a direct microwave link to WNBT in New York, whose regular programs over UHF.

RCA built and placed 50 experimental UHF television sets and 50 UHF adapters in various homes within the test area. These homes were selected so as to provide a fair sampling of reception conditions. In addition, some other manufacturers have taken advantage of this opportunity to test their own regular UHF receivers and adapters. Besides the receivers placed in the various homes in Bridgeport, a mobile receiving unit was installed in a station wagon by NBC, and used to check the reception and signal strength in practically

(*Continued on Page 34*)

SKIMMING . . .

(*Continued from Page 14*)

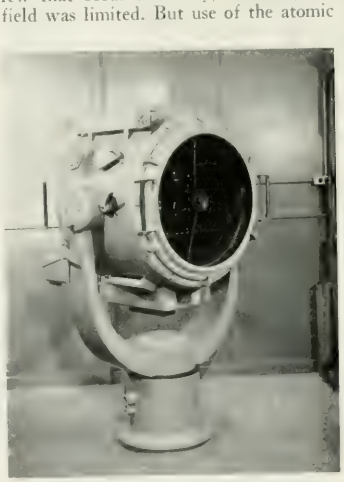
much more stable arc over a wide range of current. Previous arc controls have been based on either current or voltage. The new one takes both into account. It responds to arc drop variations of ± 0.1 volt or a current change as small as ± 0.1 ampere. The new arc searchlight reaches a stable condition in two seconds; its predecessors required two minutes.

autoradiography

The advent of atomic energy has greatly widened the field of autoradiography, the branch of photography where radioactive materials make their own shadow pictures.

Autoradiography is the technique of locating and measuring the amount of radioactive elements present in a material by means of photographic registration of the rays from the elements.

The technique has been used for years in the study of naturally radioactive parts of minerals such as radium, actinium, and thorium. As long as the radioactive elements were limited to the few that occur naturally, however, the field was limited. But use of the atomic



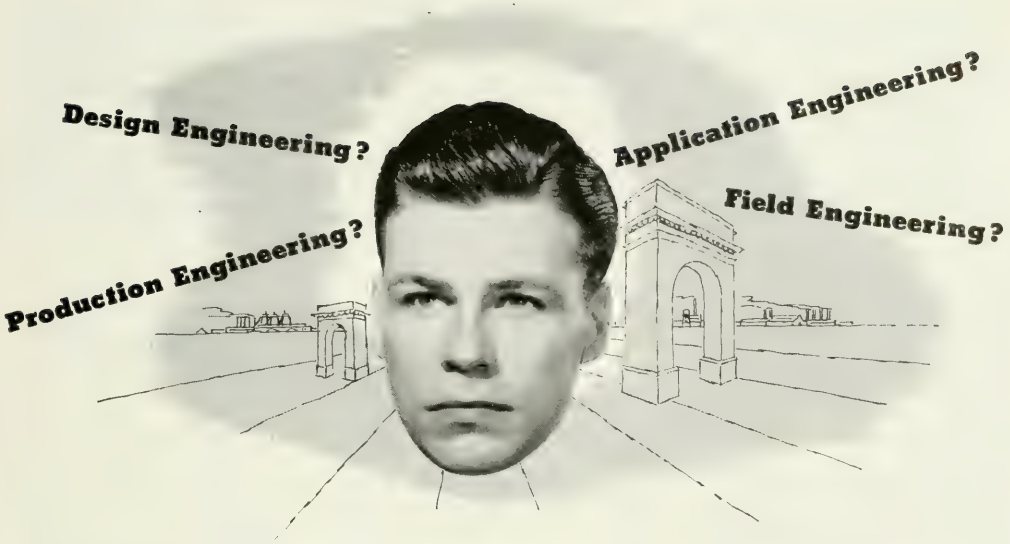
The beam candlepower of the new searchlight is rated at fifty million. (Courtesy of Westinghouse)

pile permits production of radioactive isotopes of practically all the elements of the periodic table.

By the use of radioactive isotopes in conjunction with photographic plates and emulsions, chemical elements can be traced in various substances, reactions, and processes. This is an extremely valuable tool for chemists, metallurgists, biologists, and petrographers.

In autoradiography, a photographic

(*Continued on Page 36*)



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Would you like to know more about Square D and the opportunities we offer?

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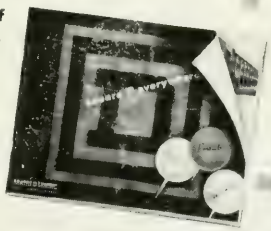
...for your copy of a 16-page "Get-Acquainted" brochure which tells a lot about Square D, its products, services, markets and opportunities.



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VOCATIONS . . .

(Continued from Page 18)

to about a low of six billion dollars on cotton to a high of twenty-five billion dollars. The uncertainty of crop yields and animal production can be modified and eliminated to a greater extent today than ever before by the agricultural engineer and other scientists.

It takes an intimate amount of knowledge of a great variety to supply agriculture with the means and know-how for obtaining high yields of production and for scientific advancement. The agronomist, animal breeder geneticist, soil scientist, entomologist, etc., all occupy an important place in our agricultural and national economy. Regardless of the field of scientific activity, there are innumerable jobs which require and which would benefit from engineering application. For convenience, we might divide the problems involving agricultural engineering application into two general classes: (a) those which are created by nature, and (b) those created by man. Four of the greatest problems of nature might be classified as follows (without attempt to list them in the order of importance):

1. Inadequate or nonuniform distribution of precipitation.

2. Inundated lands or water logged soil.

3. Unseasonal changes in temperature resulting in frost.

4. The destruction or impairment of agricultural production due to pestilence, disease, and weeds.

The problems created by man are usually the result of his disobedience of the laws of nature, such as the problem of soil erosion and the depletion of water resources. Man's problems are also a product of his desire to raise his so-called standard of living by the advancement of the arts and sciences and by greater production of all his wants and needs with reduced expenditures of time and energy.

How far have we come in solving agriculture's problems? We have developed equipment and techniques for supplementing precipitation distributed by nature, but the areas in need have only been touched. By means of dams, dikes, ditches, drain tile, mole drainage, and soil manipulation, we have converted former worthless waterlogged soils into rich agricultural lands. Still, there are thousands of fertile acres to be reclaimed which leaves little excuse for resting. In our effort to prevent frost damage we have driven in a small wedge with smudge pots, oil heaters, fans, water sprays, and infra-red radiation heaters, but the damage to crops continues virtually unchecked.

The present day trend in which farmers are beginning to accept spraying and dusting equipment as standard tools of agriculture, much like the plow, has just gotten under way. The use of such equipment promises to take much of the work out of one of agriculture's greatest problems, the eradication of unwanted plants, generally termed weeds. A word of caution might be inserted here, in that while this is desirable from the view point of production of specific products and food crops today, it may boomerang to destroy many plants which, while they have unknown uses today, may be an important key to our economy tomorrow. At all times, the agricultural engineer must be alert and perceptive of the needs and wants of the future. In terms of plant disease and pestilence, we are still much further from the answer. The control or eradication of present known plant diseases seems to bring to light new and even more devastating ones. Plants and animals developed and shaped to man's whims will always be open to attack by the secret weapons of nature.

It is not difficult to perceive the many problems that nature presents for solution by the agricultural engineer. Nature is not an abeyant old lady as some people would like to dramatize here, but a very forceful, flexible, and creative creature.

Draws a line 1/10th of a mile long with

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WORLD'S ONLY DRAWING INK FOUNTAIN PEN

with interchangeable nibs

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Engineering Graduates

CONSIDER YOUR FUTURE IN AIR CONDITIONING

WITH TRANE

Trane, a leading manufacturer of air conditioning, heating, ventilating and heat transfer equipment, is seeking qualified engineering graduates for interesting careers with its sales and home office staff.

Those selected will join the Trane Graduate Training Program at La Crosse for an intensive training course that will prepare them for responsible positions in La Crosse or in one of the company's 80 sales offices. The training period is financed by the company to make the trainee self-supporting.

Men who have completed the Trane Graduate Training Program have established an interesting pattern of success with the company. Included in this number are the president and numerous other company officers, managers of a majority of the sales offices and home office sales divisions.

Trane has continued to grow steadily and at a rate consistent with financial stability. Annual sales have increased fourfold in the last ten years. Yet, the company continues to develop new products for new fields to increase its potential business opportunities.

Based on past record and future possibilities, Trane offers you outstanding opportunities in one of the fastest growing industries. For more information write for the brochure "The Trane Graduate Training Program." It contains full details as well as a complete financial report of the company.

THE TRANE COMPANY

LA CROSSE, WISCONSIN

THE DU PONT DIGEST

Operator and foreman *check raw materials on a production control board which records every operation in a Du Pont plant.*

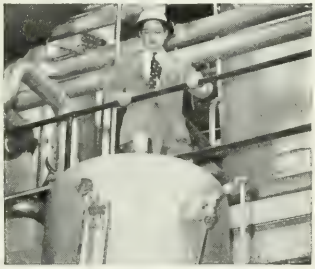
Ch. E's at Du Pont

Work as production supervisors prepares chemical engineers for jobs in management

[THIRD OF A SERIES]

The last issue of the *Digest* described the broad opportunities offered chemical engineers in research and development at Du Pont. Now let's look at the opportunities in production supervision.

In this important phase of plant operation, Ch. E.'s and others are responsible for investment in plant facilities, supply of raw materials, supervision of operation and maintenance, cost and shipment of finished products, as well as personnel relations, training and safety.



George B. Bradshaw, Jr., *B.S.Ch.E., M.I.T. '40, assistant superintendent, inspects a unit used in ammonia synthesis operation.*

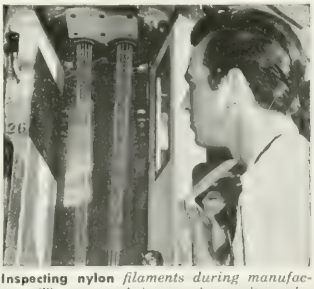
Normally, chemical engineers enter production supervision by reason of preference and special abilities. Their first step depends on which of ten operating departments they work in. For example, in one department they follow a training program as student operators. In another, training in a plant laboratory familiarizes the engineers with processes and products.

After the training period, the men are given supervisory responsibilities, usually starting as foreman. At this level they meet problems like these:

1. Occasionally, in a still connected to a sulfonator by a pipe line with a single valve, the product disappeared, and residue increased. The supervisor's study of control data showed that small amounts of gaseous sulfur trioxide were venting into the still causing decomposition of the product. His recommended installation of a positive pressure block in the pipe line eliminated the difficulty.

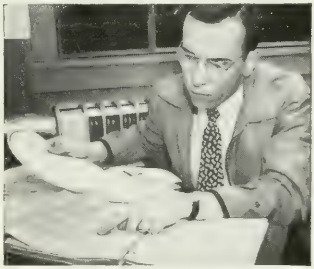
2. A high temperature batch reaction process was revised to increase production of a critical material. For safety, adjacent reactors had to be shut down as work on each unit proceeded. The supervisor planned maintenance and batch schedules to minimize costly down-time and re-trained personnel for the new process.

In solving such problems, supervisors have an opportunity to use all their knowledge and ingenuity. Equally important, they acquire the background and varied experience that prepare them for advancement to responsible positions in management and administration.



Inspecting nylon *filaments during manufacture. They are made by extruding molten polymer through spinnerets under pressure.*

NEXT MONTH—The fourth article in this series will deal with process development—to many engineers the most interesting part of plant operation.



Conrad R. Graeber, Jr., *B.S.Ch.E., Lehigh '51, control supervisor, examines flow sheets for the manufacture of methacrylates.*

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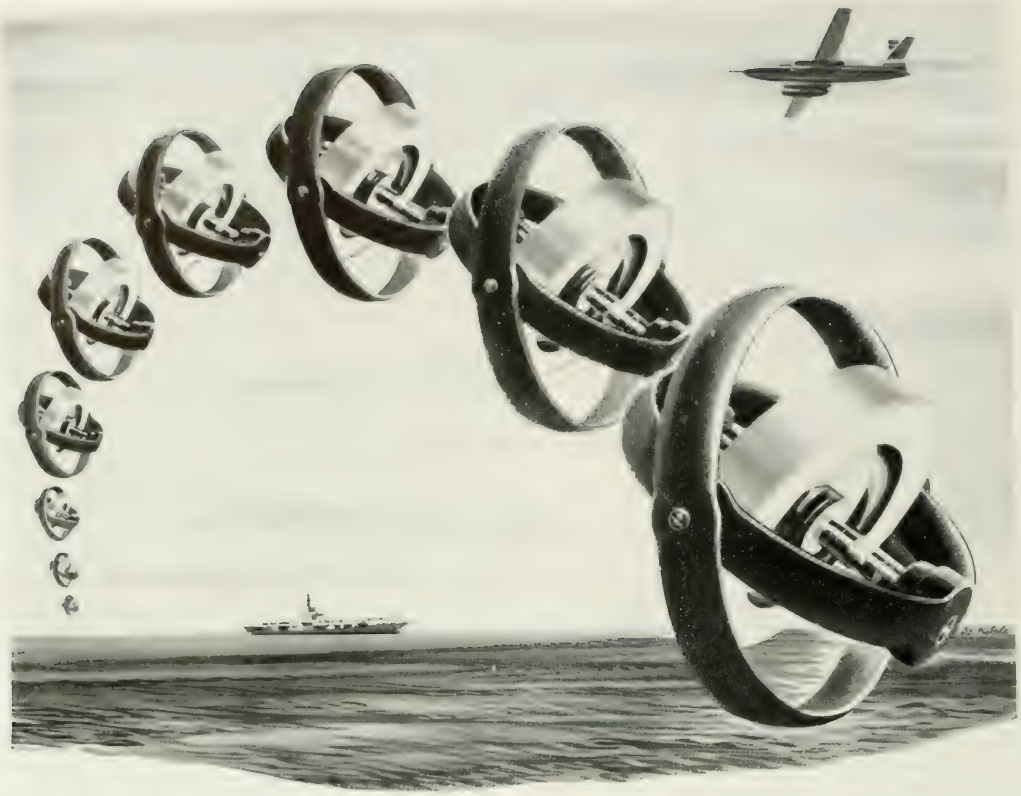

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Sperry sponsored the development of the klystron tube – the first practical source of microwave energy. From Sperry pioneering have come a complete line of Microline* instruments for precision measurement in the entire microwave field.

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Employment Section 1 A 5

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UHFTV . . .

(Continued from Page 28)

all sections of the area served by the station.

In order to obtain a direct comparison between the performance of a UHF and VHF television station, NBC built and operated a small VHF transmitter with the same antenna elevation as that of KC2XAK. From the simultaneous operation of both transmitters, valuable graphs, charts, and diagrams proving the capabilities and performance of UHF in comparison with VHF were continuously prepared. This information was turned over to the FCC as fast as it was collected and distributed to the entire television industry.

"Operation Bridgeport" was brought to a dramatic climax in September, 1951, when the entire test was summarized and the report made available to the public. The crystallization of two years of testing into one comprehensive study brought out conclusive evidence that a major television expansion is both practical and possible within the UHF band. In particular, four points of special interest to the public were proven by these tests.

Television reception on UHF can be just as clear and stable as on VHF. In some instances it is even better, for UHF pictures are not bothered by nearby X-ray equipment, auto ignitions, neon signs, or home appliances, which often distort and otherwise disturb VHF pictures.

Present television sets made by most of the leading manufacturers can be readily adapted to receive both UHF as well as VHF telecasts. Many manufacturers have already demonstrated simple UHF converters which can be readily attached to present sets.

Actual construction costs for a UHF broadcasting station will be about the same as for a VHF station. In addition to making more channels available for TV, there is also the possibility with UHF of operating a UHF station as an auxiliary of a major VHF station. Or it could be operated as a network station which would receive and rebroadcast the network programs instead of operating as a local station. This would eliminate costly studio equipment, mobile units, and extra personnel.

However, VHF will remain the backbone for television service in large cities, since it has fewer "shadow" areas in coverage and these, in most cases, can be overcome by satellite auxiliaries. UHF stations have limitations, including the requirement of more power for a given area, and deeper shadows or localities receiving no signals. UHF, then, will be most useful in areas where the VHF band is completely filled.

Thus, due to the tremendous advances in UHF during the past few years, a truly nationwide television service has become a promised reality. Foreseen only a few years from now is the time when over 2,000 television stations will dot the nation, entertaining some 50 million viewers with large, network style programs. And as these and other possibilities come before us, there emerges a view of vast new horizons, so promising that they make the present stage of television appear as little more than the beginning.

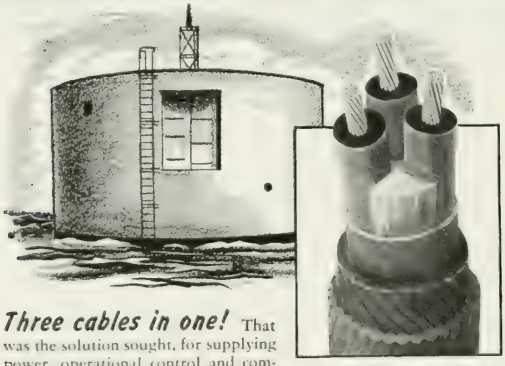
The mental patient was about to be released after twenty years of incarceration. He put on his best suit, then decided to shave himself. As he stood before the mirror, razor in hand, a nurse passing by called out, "Good luck, Harvey."

As he turned to answer her, the razor caught in the string supporting the mirror and it slipped to the floor. The patient turned around and found himself gazing at the blank wall.

"Darn it," he mumbled, "just my luck. Just as I'm ready to leave here after twenty years I cut my head off."

"I tell you I never saw such a fish. It was that long."

"I believe you."



Three cables in one! That was the solution sought, for supplying power, operational control and communication to a pumping house 4½ miles off shore in Lake Okeechobee, Florida.

As usual, Okonite engineers were consulted on the problem. Their studies showed that it was possible to combine a three-fold function in one cable. This was accomplished by the use of Okolite high-voltage insulation whose electrical characteristics permitted carrier current to be superimposed on the power conductors.

The result was a single Okonite-insulated cable—steel-armored for the 4½ underwater miles, with a non-metallic sheath for an additional 2½ miles underground—which supplies not only power and operation control, but a communication circuit as well.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE insulated wires and cables

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Chemical

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TECHNOGRAPH

Will we ever run out of gas?

RUNNING OUT of the crude oil that powers and lubricates our civilization is not an immediate danger. Scientific methods of exploration, drilling, and recovery keep pushing farther and farther into the future the day when petroleum must be supplemented by other raw materials. When that day comes, however, there is no danger that the American economy will slow down.

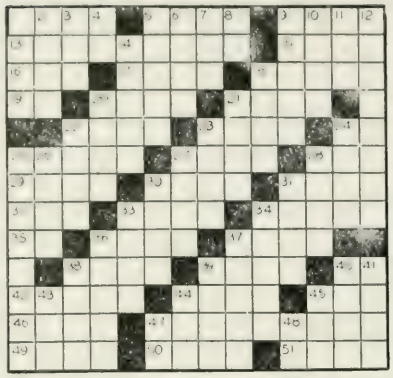
Standard Oil already knows how to make high-quality gasoline from coal or oil shale. The supply of these raw materials is far greater than the reserves of petroleum. It is important that the research and development work in the entire field of synthetic fuels continue so as to lower the cost and raise quality still higher.

Work with synthetic fuels is only one example of how Standard Oil plans ahead to serve its customers. By working to keep this company in the forefront of one of America's most competitive industries, our researchers and engineers are helping to keep America itself ahead and to make life better for every American.

Standard Oil Company

STANDARD

(Answer on Page 40)

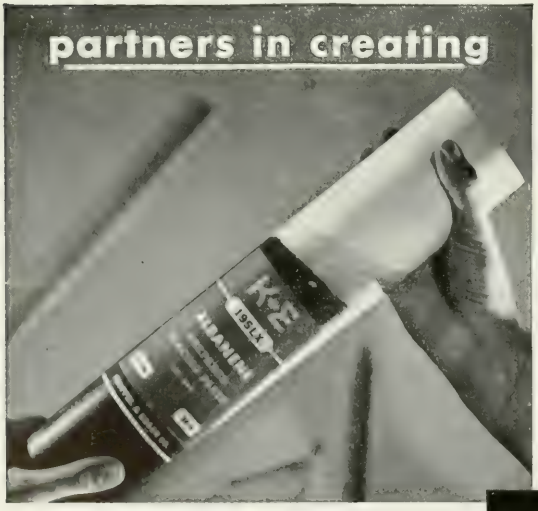


ACROSS

1. Natural
5. [illegible]
8. [illegible]
12. [illegible]
19. [illegible]
20. State
21. [illegible]
22. Row
23. Invented the [illegible] clock system for recording [illegible] time
24. Musical note
25. An electron beam dispels this fast
27. Better conductor of electricity than copper
28. Large hardwood tree
29. Belonging to us
30. Box
31. Scandinavian epic poem
32. Individual
34. Virginian who helped develop the tungsten-filament lamp
34. Radon
35. Army officer: abbr
36. Hebrew letter
37. Fish's appendages
38. What a video audience does
39. Rounded projections
40. Accomplish
42. Discourage
44. Shove
45. Distant
46. Metric weight
47. Developer of frequency modulation
49. C G S work units
50. Replica
51. Patented the "telautograph" in 1893

DOWN

1. Former Russian ruler
2. Sicilian volcano
3. Guided
4. Chinese distance measure
5. Fossil resin, strongly electrified by rubbing
6. Ogle
7. Pig's home
8. Small weight: abbr
9. Coral Island
10. Eat a banquet
11. Corroded
12. First to measure the electric charge of an electron
14. Book of fiction
18. Fungus yielding penicillin
20. Is sick
21. Pallid
22. Fatigue
23. Landlord of an inn
24. Starch used in puddings, etc
25. Developed the cathode-ray tube in 1927
26. Search
27. Slit
28. Grain popular in Scotland
30. Severs
31. Moral lapses
33. Scoff
34. A state of darkness
36. Abounds
37. Finical
38. Male deer
39. Chunk
40. Developed the "dip needle" in 1827
41. Carousal
43. Go astray
44. In favor of
45. On behalf of
47. Popular form of electricity: abbr
48. Football position: abbr



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SKIMMING . . .

(*Continued from Page 28*)

emulsion is placed in contact with a test sample of material and self-portrait of the surface registered by means of the emanations from the radioactive atoms in or near the surface.

If the surface is highly active, the picture may consist of a series of density values, as obtained in an ordinary photograph. In a sense, such pictures are like a contour map. The various densities of the negative indicate the intensity of radiation at each point on the surface and, therefore, the amount of radioactive material present.

When the radioactive atoms in the material are very sparse, an accurate microscopic survey of the contacting emulsion can be made after development and the concentration of radioactive atoms determined from track counts.

The survey method is tedious, but it permits very great sensitivity. It has the advantage under certain circumstances of giving very great resolving power since the origin of the tracks can be localized within about 1 10,000 of an inch.

Emulsions of various sensitivities to beta radiation have been made available for autoradiography. Usually the highest speed emulsion suitable for a desired resolving power is chosen for a particular job. The fast emulsions have large grains and low resolving power. The fine grain emulsions have good resolving power but low speed.

sterilization of blood plasma

Blood plasma, for the treatment of military casualties as well as civilians, may soon be sterilized with high-energy electron rays more efficiently than with methods now employed. Blood plasma is one of the many materials on which electron or cathode ray sterilization might be used effectively.

The major advantage of cathode rays in killing germs and molds is that such sterilization may be accomplished without heating the material. This is particularly important for certain drugs, and other products, that might be damaged by heating.

Ultraviolet rays are now employed for sterilization of blood plasma. While these rays do not heat the plasma, they do not penetrate into it as deeply as would the high-voltage cathode rays. Thus sterilization with electrons might be more efficient.

Further laboratory work is needed in order to make sure that cathode-ray treatment of blood plasma does not cause the formation of any poisonous compounds.

This type of sterilization can also be used to sterilize foods such as meats, vegetables, bread, honey, and many other products.

Takes a lot to lay a carpet in the jungle

The scene is "darkest Africa".

But Africa is lightening. Man's quest for minerals, for new areas for agriculture and trade, is slashing ultra-modern, glaring-white air strips in once impenetrable jungle.

Those pavers, portable air compressors, pumps and air tools—such as you might see working a city street—are Worthington Blue Brutes going to "lay a carpet" in that hole in the jungle.

Thus, Worthington, a major producer of equipment for public works, industry and farm, brings the fruits of American technical genius to the strange places of the world.

And illustrates, too, how the unique American talent of *diversification* helps public, employees and stockholders. For Worthington makes many things—not just construction equipment and pumps, but also engines, water works machinery, power transmission, petroleum equipment, air conditioning and refrigeration, many others.

Such diversification builds *stability* . . . makes Worthington, 112 years old, a strong link in the far-flung chain of American business.

Worthington Pump and Machinery Corporation, Harrison, New Jersey.

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Around the World

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Good Water and Sanitation—engines pumps · water treatment · comminutors air compressors · air tools

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Petroleum Products—compressors engines · pumps · chilling equipment refrigeration · decoking systems

More Abundant Food—compressors fertilizer mixers · air conditioning refrigeration · pumps

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But I haven't majored in aeronautical engineering

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It's your aptitude, your knowledge of engineering principles, your degree in engineering that count.

Those—plus the opportunity Lockheed is offering you—are all you need for a career as an aircraft engineer. In Lockheed's special program for engineering graduates, you may go back to school, or you may convert to aircraft work by doing—on-the-job training. But whichever it is, you receive full pay while learning.

But Lockheed offers you more than a career. It offers you a new life, in an area where living conditions are beyond compare. Outdoor living prevails the year-'round. Mountains, beaches are an hour from Lockheed.

See your Placement Officer today for the details on Lockheed's Aircraft Training Program for engineers, as well as the better living conditions in Southern California.

If your Placement Officer is out of the illustrated brochures describing living and working conditions at Lockheed, write M. V. Mattson, Employment Manager

Lockheed Aircraft Corporation

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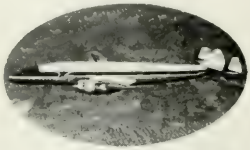
The P-38 Lightning - first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History



The Super Constellation – larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

This Plane will make History

The jet of the future – the plane you will help create—belongs here.

This plane – which exists only in the brain of an engineer like yourself is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.

Security

A FAMILY had failed to make a living on a worn-out New England farm. Did they demand government subsidies, checks for crops they didn't raise, high prices for crops to be burned?

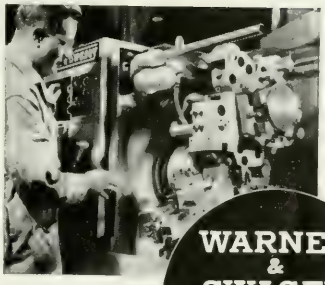
They would have scorned such things—scorned and feared, for they knew from days under a foreign despot that where government *money* goes, government *control* goes, too.

No, this family put everything they owned in that wagon, and *walked* beside it 2,000 miles, westward. They didn't know what was ahead, but they were determined to keep on going until they found a place of freedom where they could keep their self-respect.

They were English, Scotch, Dutch, Italian, French—people from many places—all, now, Americans. They knew that the only happiness is from self-respect, and the only way to self-respect is to earn your own way, not whine for something for nothing.

Their sons and grandsons started grocery stores, became mechanics, saved their money and started factories. American machines bought by American thrift made the factories grow.

And that's America. Made by people willing to walk 2,000 miles beside a wagon—to find opportunity. If such people are gone, if all we've got left are soft weaklings who want to be taken care of, then in truth American manliness is dead, that 2,000 mile walk was wasted, and there is nothing left of America but a hollow shell.



YOU CAN MACHINE IT BETTER, FASTER, FOR LESS WITH WARNER & SWASEY TURRET LATHES, AUTOMATICS AND TAPPING MACHINES

Professor Zotz was a sworn enemy of coeducation. "It's impossible," he told a group of friends "to teach a young man mathematics if there's a girl in the class."

"Come now, professor," someone objected, "surely there must be an exception to that."

"There might be," snapped Zotz, "but he wouldn't be worth teaching!"

* * *

A sweet old lady, always eager to help the needy, spied a particularly sad looking old man standing on a street corner. She walked over to him, pressed a dollar bill into his hand and said, "Chin up."

The next day, on the same corner, the sad old man shuffled up to the lady and slipped ten dollars into her hand.

"Nice picking," he said in a low voice. "Paid nine to one."

* * *

Two Air Force men watched a plane unload at a Korean air field. "Look at the terrifying insignia on the side of that plane," one exclaimed.

"Shhhhh. Not so loud," the other warned, "that's the squadron commander looking out the window."

* * *

As the conductor called out the various names of the streets, the country couple became more and more uneasy. The conductor called "Maple," then "Adams," then "Rosewood." The country man grew very fidgety and, turning to his wife said, "Isn't it time we got off."

"Don't show your ignorance, Matthew," she said. "Wait until your name is called."

* * *

Arriving home earlier than usual, hubby found his wife in the arms of his best friend. Said the interloper: "I love your wife and she loves me. I'll play you a game of cards for her. If you lose, I want you to divorce her and I'll marry her. If I lose, I promise never to see her again. Will you play a game of gin rummy for her?"

"Yes," replied the husband, "and how about playing a penny a point to make it interesting?"

* * *

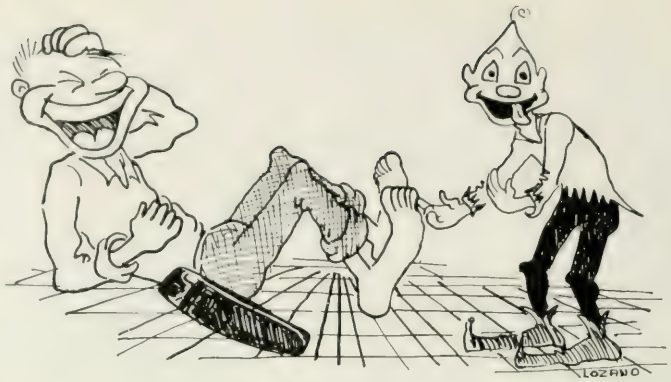
A man was passing a neighborhood store and heard such a terrific racket he decided to investigate. He found no one in the place but the proprietor.

"Whose were you arguing with in here?" he asked. "You're all alone."

"I get bored," explained the proprietor. "So I talk to myself."

"Well," the man reasoned, "if you talk to yourself why do you have to argue?"

"Because," the owner retorted, "I can't stand a liar!"



TECHNOCRACKS

Engineer's Voice (over the phone): "Say, Mable, may I come over tonight?"

Coed's Voice: "Sure, Pete, come on over."

Engineer's Voice: "Why, this isn't Pete."

Coed's Voice: "This isn't Mable, either."

* * *

He (at movies): "Can you see all right?"

She: "Yes."

He: "Is there a dratt on you?"

She: "No."

He: "Seat comfortable?"

She: "Yes."

He: "Mind changing places?"

* * *

The mayor had just laid the cornerstone for a new wing of the hospital and the spectators awaited his speech.

"What can I do, Mary?" whispered the Mayor to his wife. "My speech! I've laid the cornerstone on top of it."

* * *

I want my peas with honey, and,
like I tell my wife,
They do taste kinda funny, but it
keeps them on my knife.

* * *

Crossword Answer

T	E	L	L		A	L	S	O		A	D	A M
S	T	E	I	N	M	E	T	Z		T	I	T I
A	N	D		O	B	E	Y		M	O	N	E L
R	A		A	V	E	R		P	O	L	E	L
		T	I	E	R		H	A	L	L		S I
C	H	I	L	L		G	O	L	D		O	A K
O	U	R	S		C	A	S	E		S	A	G A
O	N	E		J	U	S	T		N	I	T	O N
L	T		T	E	T	H		F	I	N	S	
I		S	E	E	S		L	U	G	S		D O
D	E	T	E	R		P	U	S	H		F	A R
G	R	A	M		A	R	M	S	T	R	O	N G
E	R	G	S		C	O	P	Y		G	R	A Y

(Puzzle on Page 36)

The minister had been asked to present the prizes to the winners of the local dog show, but when he got there he was outraged at the dress of some of the girls.

"Just look at that young person there with the cigarette, close-cut hair, and breeches," he cried to a bystander. "Is it a boy or a girl?"

"It's a girl," replied the other. "She's my daughter."

"Oh, forgive me, sir," apologized the preacher, "I never dreamed you were her father."

"Im not," was the reply, "I'm her mother."

* * *

Bachelors know more about women than married men. That's why they're bachelors.

* * *

In a secluded corner of their club, a film actor was being berated by his wife. "You mean skunk," she announced. "Of all low-down reptiles I think you are the worst!"

The actor, noticing that a group of friends had taken a table within earshot, quickly broke in, "Quite right, dear. And what else did you say to him?"

* * *

A Russian lecturer who insisted that democracy worked only for a few was asked to explain a photo of an American parking lot crowded with cars.

"Aha, look at the hub caps," he said. "Most of them are owned by one fellow—Chevrolet!"

* * *

"An inmate just escaped from an asylum. He was tall, thin and weighed 250 pounds."

"Tall, thin and weighed 250 pounds?"

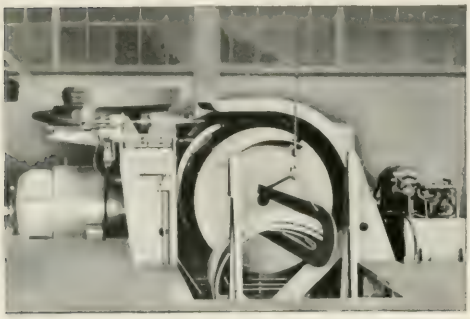
"I told you he was crazy."

illinois technograph

.25

april, 1952

Another page for **YOUR BEARING NOTEBOOK**



How TIMKEN® bearings help a drum stay fit as a fiddle

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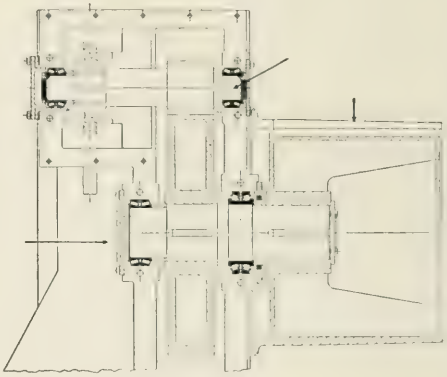

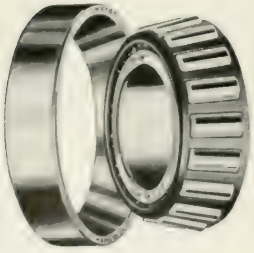

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NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬯ AND THRUST —⬯— LOADS OR ANY COMBINATION

It's Up to You . . .

The recent disclosures of diminishing reliance on moral principles on the campus, in government and in certain industries prompts a re-examination of the character of professional ethics as related to the engineer.

A recitation of the recapitulation of the Code of Ethics as prescribed by the Western Society of Engineers seems in order, it follows: "The ethical standards of the engineering profession should be those of a fraternity. The engineer should recognize that he is endowed by the profession and the state with specialized knowledge for peculiar judicial and responsible public service involving the life, safety, comfort and convenience of his own and coming generations, and that in response to these he should so conduct himself as to be appreciative of his indebtedness to his profession for his opportunity and make return by every effort, by a life of special usefulness devoid of unseemly greed, and filled, if possible, with a multitude of those small courtesies, the practice of which encourages the spirit of forbearance and is helpfully conducive to the fine art of living well together."

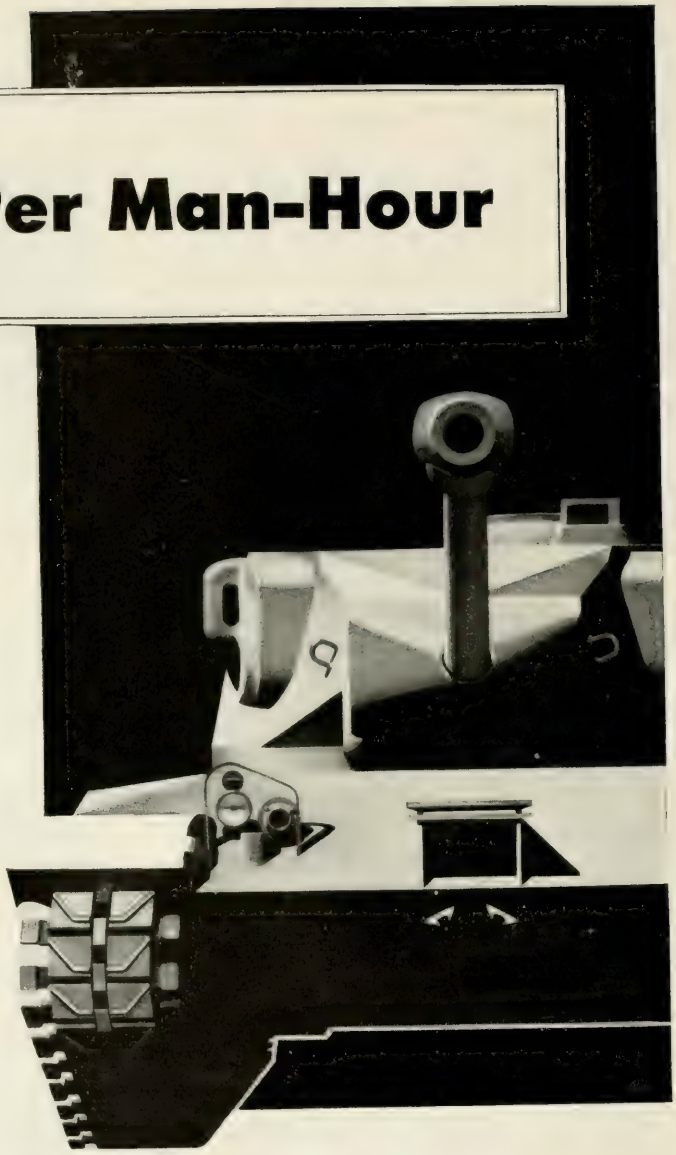
It is significant, I believe, that by and large, professional engineers have not been involved in scandals associated with public morals. The engineer has been tutored well in the classroom, and on the job, along the paths of fair dealing, trustworthiness and honesty.

The heritage of the engineer is one of devotion to duty, perserverance and unimpeachable conduct. One who might be inclined toward devious practices might well examine the life histories of those engineers who made this country great. The engineer in social, professional or political life has consistently conformed to his code and the public has rewarded him for it.

But let's not think the battle is over. Each one of us, every day, is faced with alternate solutions of an ethical situation which must be met. The way we handle them while we are in the classroom will be a guide to the methods of attack to be employed in later life.

The standards have been set down, the rest is up to you.—W.H.B.

More Per Man-Hour



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COLLEGE MEN . . .

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the illinois technograph

volume 67 number 7

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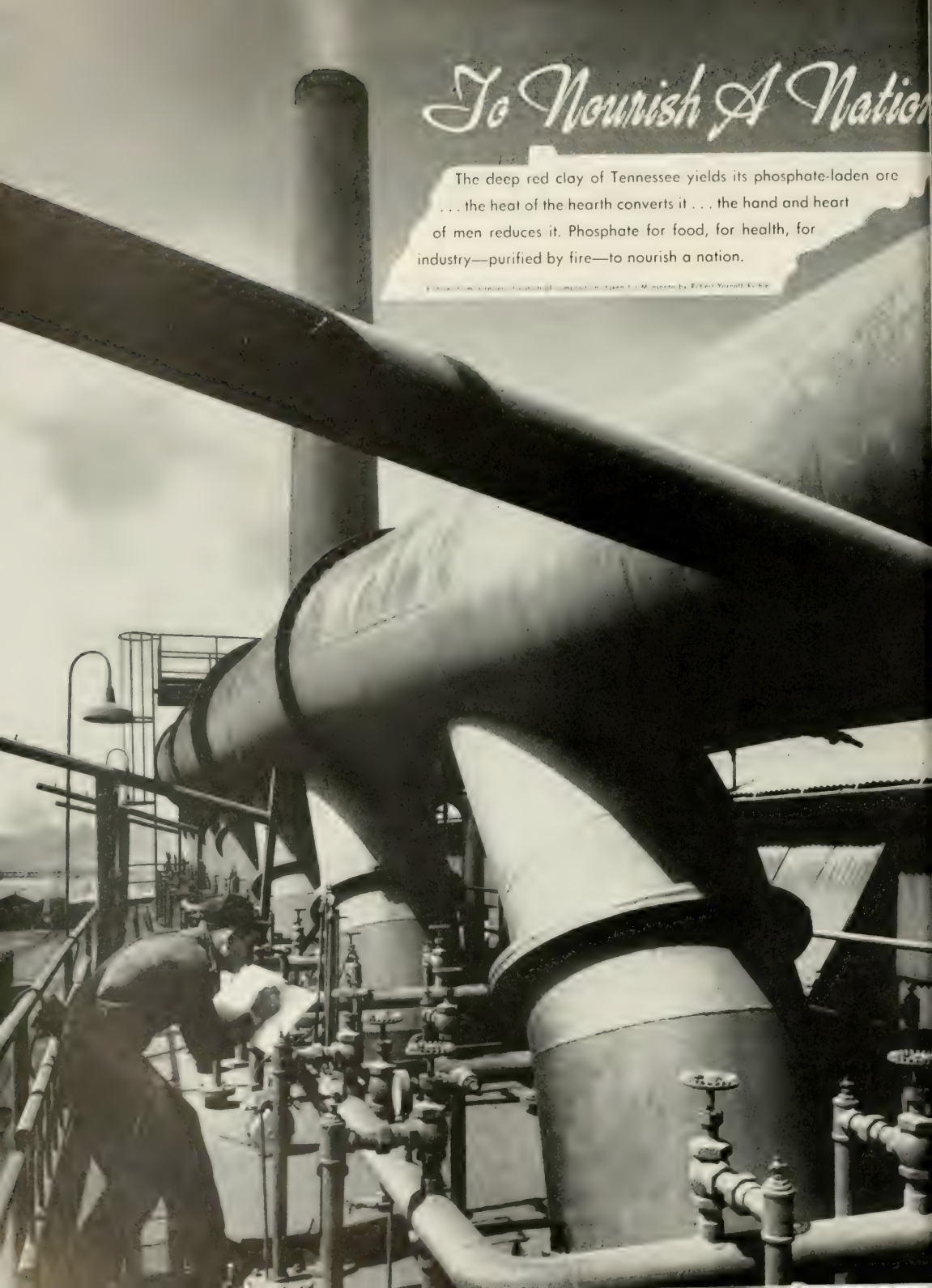
our cover

The chemical industry, so vital to our security, is exemplified in this view of a Tennessee phosphate plant. The chemical engineers we salute in this issue are helping to provide America with the materials she needs for farm, home and industry. Chemistry has taken the processes of nature and applied them to the needs of man. (Cut courtesy Monsanto Chemical Company).

our frontispiece

"To Nourish a Nation," the chemical industry has led in the development of fertilizers, food preservatives and important by-products associated with food processing. The phosphate industry is a leader in providing much needed nutrients in the soils of America's farms. Chemical engineers have developed numerous additives to soils which enable the farm to increase land output. (Cut courtesy Monsanto Chemical Company).



To Nourish A Nation

The deep red clay of Tennessee yields its phosphate-laden ore . . . the heat of the hearth converts it . . . the hand and heart of men reduces it. Phosphate for food, for health, for industry—purified by fire—to nourish a nation.

cracking the whip over . . .

THE BIG CATS

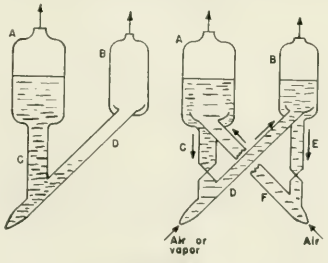
by Daniel Stanfill

The fluid catalytic cracking process emerged from the laboratory during the war years. Today it shows many advantages over other processes used by the industry. Once a unit is running, the heat requirements of the various parts of the unit are balanced by the heat generation of other portions, and little, if any, outside heat is required. Higher yields of the most desirable products are obtained and only a small percentage of these products need further processing. It can successfully crack naptha cuts, kerosene, light or heavy gas oil, and some types of reduced crude oil. It can be operated to produce either aviation gasoline, high grade motor gasoline, or raw materials for the production of chemicals and synthetic rubber. The simplicity of the process eliminates expensive, intricate mechanical equipment. Continuous and very accurate control may be accomplished simply by using valves.

The catalyst cracking process also allows great flexibility of operating conditions. Such things as the catalyst-to-oil ratio and space velocity permit changing the relationship of desirable products over a wide range to meet market demands. Today, the catalytic process has largely replaced other processes and is a basic tool for breaking down long-chain and high-molecular-weight hydrocarbons into molecules that boil within the gasoline temperature range.

The fluid catalytic cracking process employs a finely divided catalyst suspended in gas or vapor, so that it flows through the equipment with flow characteristics resembling those of a liquid. The catalyst is brought into intimate contact with the oil, causing the oil to change its molecular structure.

The success of the process depends upon the fluid principle. As with most engineering designs, the idea is quite ingenious but is relatively simple in theory. In the accompanying diagram (figure 1), it is desired to move the catalyst from vessel A to vessel B. The powdered catalyst (average particle diameter, 0.002″) falls down pipe C, but at the junction of C and D it packs tightly and the flow is stopped. By two simple additions, the catalyst can be made to flow from A to B, and at the same time a complete cycle is set up. These changes are shown in figure 2. By the addition of a valve at the lower end of standpipe C, and the injection of air or vapor at the bottom of D, a carburetor condition is set up which carries the catalyst aloft as a fluid to vessel B. No mechanical force is used; the pressure head maintained in A plus



Figures 1 and 2

the force of the hot partially-packed catalyst in C is sufficient to overcome the opposing forces—the pressure in B, the force of gravity, and friction loss during the movement through D. A similar set of return pipes, E and F, are attached to vessel B and the cycle is complete.

In actual operation, vessel A is the regenerator for spent catalyst, and vessel B is the reactor for the fresh catalyst and oil vapor charge. Some of the numerous advantages of this fluid principle are as follows: A highly turbulent bed in the reactor (vessel B) provides intimate contact between catalyst and vapor. The ability to closely control reaction conditions over a wide range produces optimum yields with uniform quality of products. Continuous uniform regeneration (in pipe F and vessel A) is obtained with a minimum degradation of catalyst activity. The fluid catalyst may be circulated freely without regard to limitations of mechanical transfer equipment. Flows are maintained by self-perpetuating hydrostatic heads (at the bottom of pipes D and F.)

The principle disadvantage of the catalyst cracking process is the eroding or "sandblasting" effect that the moving catalyst particles have on the equipment. A wide variety of catalysts are used. For example, a synthetically produced silica-alumina catalyst yields the highest octane number and a lesser amount of gasoline, while more gasoline with a lower octane number is produced by using a natural silica-alumnia catalyst. Yet the only difference between these two silica-alumina catalysts is in their physical form; the synthetic is smooth and has less exposed surface per unit of mass than the natural rough-ground catalyst.

Figure 3 shows a simplified diagram for a typical M. W. Kellogg Fluid Catalytic Cracking Unit. Hot catalyst at a temperature of approximately 1100°F passes from the regenerator into the regenerator standpipe and flows down to the oil injection point where it flash-vaporizes the fresh-oil charge which has been preheated to balance the total heat requirements of the reaction. The mixture of oil vapors and catalyst is forced up the reactor feed line by the pressure head maintained in the regenerator plus the force of gravity exerted on the dense catalyst in the catalyst standpipe, the pump serving merely to bring the oil to the oil injection point. The hot mixture then enters the reactor where the catalyst settles to a well-defined level and forms a bed, the depth of which regulates the time of reaction. The bed is maintained in a fluid turbulent condition by the entering feed vapors. Continually passing upwards, these oil vapors effect intimate contact with the catalyst and produce a uniform temperature (900-950°) throughout the bed. As cracking progresses, coke is formed on the catalyst.

The spent catalyst, laden with coke, is continually and automatically withdrawn through a slide valve to the spent-catalyst stripper, where the adsorbed and entrained vapors are dissociated from the catalyst and carried by a counter stripping medium back into the top of the reactor vapor space. Spent catalyst in the stripper separates

(continued on page 20)

The Unit Operations Laboratory, largest laboratory in the building, extends through three stories.

the Technograph features the . . .

Chemical Engineering Division

by Tom Tucker, ch.e. '53

In this day, it is news when an engineer has time for athletics, but in 1868, one year after the University was chartered, every chemistry student at Illinois could be found on the baseball diamond. However, it was not as easy a life as it appears to have been—the department of chemistry was located in a building on the playing field. Setting a precedent which is still being followed, the department grew until a new building was constructed for it. That building is still standing. It is so small that most students can not see why it was ever built. The building is Harker Hall.

In 1891, a young man named Samuel Wilson Parr came to the University as a professor of applied chemistry. Ten years later, he initiated the curriculum of chemical engineering at Illinois, one of the first five in the country.

At the beginning of this century, there were no chemical engineers as we know them today. The industrial chemist found the best method for production on a commercial basis by trial and error. He paid little, if any, attention to the mechanical end of production, leaving this entirely in the hands of the mechanical engineer. The mechanical engineer did his job on a cut-and-try basis. Neither the chemist nor the engineer made any effort to see the other's problems. This was the situation when the chemical engineer entered.

At the dedication of the East Chemistry building in March, 1951, Doctor Donald B. Keyes, formerly of the University faculty and now with the Heyden Chemical corporation, made the following statement on the nature of chemical engineering: "Chemical engineering is the art of translating test tube results from the chemical laboratory into full-scale commercial production. If success is obtained, the business prospers and the public is benefited both from the standpoint of health and happiness."

Chemical engineering requires an extensive background of chemistry. For a bachelor's degree, the Illinois chemist takes only 18 more hours in chemistry than does the engineer. Of these 18 hours, 12 are electives which the engineer often takes.

The second requirement for a chemical engineer is a thorough knowledge of the unit operations: fluid flow, heat transfer, distillation, evaporation, and filtration. It is the policy of the curriculum, according to Doctor H. F. Johnstone, head of the division, to provide the fundamentals, at both the undergraduate and graduate levels, in such a way that the chemical engineer from Illinois can work in any chemical industry. The student is taught analytical thinking and interpretation of data as well as the basic subject matter. He is trained in such a way that he can do many of the jobs of the electrical or mechanical engineer.

That the division has lived up to its aims in the past is evident from the success and reputation of its graduates. Among the best known are Professor E. R. Gilliland, '30, head of chemical engineering at M.I.T.; Professor E. W. Comings, '30, head of chemical and metallurgical engineering at Purdue; Frank Smith, '30, manager and director of research of Pan American Petroleum Company; Dotor D. M. Wroughton, '30, head of the Atomic Energy Division of the Westinghouse Company; Doctor R. L. Pigford, '42, University of Delaware; Doctor W. L. Faith, Ph.D. '32, Corn Products Refining Company; Doctor N. W. Krase, '18, of the Du Pont Corporation; S. D. Kirkpatrick, '16, McGraw Hill Book Company; and many other Illini chemical engineers.

Further evidence of the quality of the work of the division is found in the number of prize-winners in the student contests sponsored by the American Institute of Chemical Engineers. In 17 years of competition, the University has won five first prizes and six other prizes, a record which surpasses that of any school in the country. The University of Illinois also ranks first in the number of undergraduate students who go on to take advanced degrees in chemical engineering. Doctor Johnstone and his staff encourage their students to take graduate work at some other school in

order to broaden their training and get a different viewpoint.

Still another first belongs to chemical engineering, Illinois style. The first laboratory to study high pressure reaction in any university in the country was established here in 1926.

Since the curriculum was started in 1901, about 1300 students have received the degree of Bachelor of Science in chemical engineering. The largest number of graduating seniors was 88 in 1946. At present, there are 155 undergraduate chemical engineering students and 33 graduate students on the campus. Other undergraduate students are enrolled at Chicago Undergraduate Division at the Navy Pier.

There are two optional curricula in chemical engineering, one requiring four years of study and the other five years. The four-year curriculum is for the high school graduates who have had good training in high school chemistry, physics, mathematics, and German or French. In this curriculum, there are a number of special courses which are offered only to chemists and chemical engineers. These courses have accelerated schedules which are made possible by the excellence of the high school training. For students who can not get the training necessary for the four-year curriculum, the five-year course has been established. This is essentially the same as the shorter course with the difference in the number of hours of elementary chemistry, mathematics, and language. There are also more electives in the five-year curriculum, so that more liberal arts and economics courses may be taken. Students who are particularly interested in sales and administration in the chemical and oil industries often take the longer curriculum.

With the value of audio-visual education in mind, a fully equipped projection booth was placed in the main lecture room.

The division of chemical engineering also offers an optional curriculum in bioengineering for students who are interested in the fields of industrial fermentation, antibiotics, pharmeceuticals, and the like. Graduates of this option receive the same degree in chemical engineering as those in the regular curriculum. Illinois was among the first to offer training in this field. In charge of bioengineering is Doctor R. K. Finn. Doctor Finn came to Illinois three years ago from the University of Minnesota.

It was mentioned earlier that the chemistry laboratory was formerly located in Harker Hall. In 1901, the department moved into a new and larger laboratory which is now the west half of Noyes laboratory. The east portion of that building was added in 1916. Then the Chemistry Annex was built in 1932. Still there was not enough room for "the strongest department of chemistry in the country," as it is referred to by Doctor James B. Conant, president of Harvard University. In 1947, construction was started on the new East Chemistry building for the chemical engineering and biochemistry divisions of the department. This $3,400,000 building was opened to classes in February, 1950.

The facilities of the new building are unsurpassed by any college laboratory in the country. Of the seven floor levels in the building, two are devoted to ventilation and maintenance.

The main laboratories in the new building are the unit process laboratory, the high pressure laboratory, the unit operations laboratory, and the process development laboratory. The high pressure laboratory, located on the ground floor, is capable of working up to 100,000*psi*. It is the only one of the four laboratories which does not occupy more than one floor level.

The process development laboratory, or pilot plant, runs through the third and fourth floors. There are two steel-grill mezzanines above the lower floor level at 9 and 16 feet. These mezzanines provide three working levels to enable the operation of tall equipment in the laboratory. It is in laboratories such as

(continued on page 28)

The main lounge of the East Chemistry building features the latest developments in modern design and comfort.

engineers strut their stuff at the . . .

1952 Engineering Open House

by John Schultz, cer.e. '52

St. Patrick made his initial appearance on campus this year inconspicuously and ahead of schedule. He arrived on the night of March 12, two days before he was expected, in a green sawed-off rocket ship which landed on the lawn of the Electrical Engineering Building in the dead of night. Though nobody saw him land, the evidence of his presence was unmistakable. The rocket ship had been spotted hurling toward the area from outer space several days before by celestial observers, but the time of his arrival could not be determined. On the morning of Thursday, March 13, however, a group of engineers returning home after burning the all-night study oil spotted the contraption, which upon investigation proved to be that of the patron saint himself.

It was later discovered that the purpose of St. Pat's unexpected early arrival was to discover the whereabouts of the Blarney Stone, missing since two years ago.

But when no word was heard from him, it was feared that he also had become lost, strayed, or kidnaped. However, he returned in time to start off the festivities on Friday, emerging ragged and worn from a Green Street sewer. By that time a large crowd of spectators had assembled on the engineers' domain, awaiting the arrival of the man without whom Open House activities could not start. St. Patrick announced that his search for the Blarney Stone had been futile, although he had unrelentlessly traced down the rumor that the Stone was in the possession of some unscrupulous Ag students.

St. Pat then got aboard his waiting green convertible and toured the campus, followed by the parade of floats. Leading the parade was a huge green snake, carried by members of Sigma Phi Delta, engineering social fraternity.

The parade consisted of floats designed by various engineering societies and fraternities. Among the more eye-filling floats was one built by members of the American Foundryman Society carrying the slogan "We Make Models." Riding the float was a model, the like of which is seldom seen even in the most modern foundry.

The aeronautical engineers' float also brought forth whistles and wolf-calls. Entitled "Venus or Bust," it had both.

The trophy for the best float was given to the boys of the American Society of Mechanical Engineers.

After the passing of the parade, the crowd rapidly dispersed to view the multitude of displays in the buildings surrounding the Boneyard. The first stop on the program was Talbot Laboratory. The show-stopper here was an impressive demonstration of the breaking of a large concrete cylinder by the 3,000,000 *lb.* hydraulic testing machine. The cylinder was shattered like a match-stick by the steel muscles of this Samsonian machine.

Other exhibits demonstrated by the department of theoretical and applied mechanics included the testing of structural joints on a 200,000 *lb.* repeated load machine, determination of engineering properties of soils, different mechanical vibration systems, and special equipment and specimens of plastics and laminations.

From Talbot Lab, the arrows led to the Foundry where castings were made of different metals; to Aeronautical Laboratory B, where airplane engines and models were on display; to the Mechanical Engineering Laboratory, where power units and other equipment were demonstrated; thence to the Transportation building. The general engineering drawing department, harbored in the Transportation building, won the trophy for the best exhibit. The displays included 19 patent drawings which have changed civilization, dratting equipment; 50 different types of slide rules; and aircraft drawing and lofting. The use of the airbrush was demonstrated, as were methods of reproducing engineering drawings, and the use of black light in teaching descriptive geometry. Souvenirs were given to the visitors.

The Mining Laboratory offered demonstrations of mining apparatus and displays. The Metallurgy Lab housed demonstrations of metal crying out loud, heat treatment of metals, and microscopic examination of metals. Movies also were shown.

The wind tunnel was in operation in Aeronautical Lab A.

One of the popular exhibits in the Ceramics building was the making of souvenir porcelain enameled "dog-tags," on which visitors were invited to write their names. Green-glazed clay shamrocks also were given away as souvenirs while the supply lasted. Among the exhibitions given by the ceramics boys were: jiggering, throwing, and slip casting of pottery; brick making; and smelting of enamels. Microscopy and pyrometry equipment were displayed, as well as many types of ceramic wares.

The mechanical engineers exhibited methods of tool designing, welding, heat treating, and machining; internal combustion engines; thermodynamic studies; and fuels and lubricants.

A lecture demonstration of various physical phenomena was given in the Physics Laboratory; and displays of light and sound were offered. The physicists also conducted a tour of the Betatron building.

Civil engineers and sanitary engineers exhibited and explained all phases of their fields in Civil Engineering Hall. Two popular movies were shown.

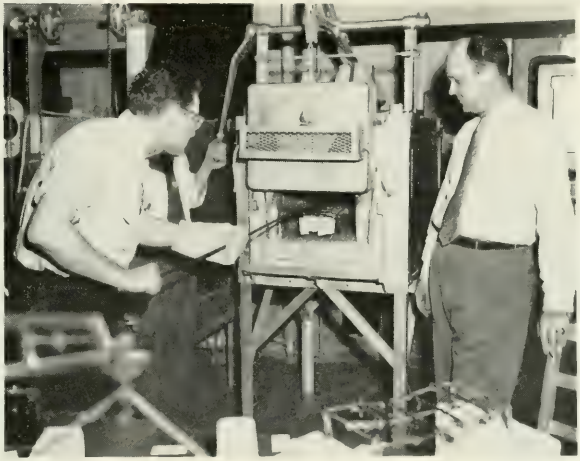
The final stop on the engineering campus was the Electrical Engineering building, where power, communications, electronics, and illumination were well represented.

The new Chem Engineering building also was on the Open House list. The six fundamental operations of chemical processes were demonstrated in the unit operations lab. These are: distillation, extraction, filtration, heat transfer, absorption, and evaporation. Free hydrogen hydroxide cocktails were featured. St. Pat's weekend had a double meaning for the Chem E's, for the AIChE held its regional convention here at that time.

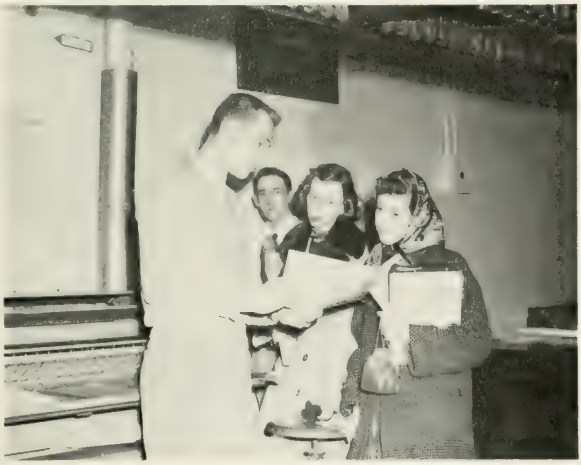
Free bus service was given to the Chemical Engineering building, and to the Ag Engineering building, Armory, Abbott Power Plant, Betatron building, and the Railway Exhibit.

The Open House was closed at 6:00 p.m. Saturday to allow the all-but-exhausted engineers to spruce up for St. Pat's Ball, a fitting climax to a busy weekend.

Above: T.A.M. department tests strength of concrete cylinders. Right: Kiln baking process used for ceramics. Below: Weaker sex admires prize-winning G.E.D. display.



Above: AFS float passes in review during Open House Parade. Below: After effects of strength testing in Talbot Lab.



introducing . . .

by Oliver Smith, m.e. '54, Duane Loofbourrow, gen.e. '53 and Tom Madden, m.e. '54

ROBERT K. FINN

Students at the University of Illinois found that in the fall semester of 1949 a new course had entered the time table. Entitled "bio-engineering," this course was found in the chemical engineering division and was instructed by Robert K. Finn, assistant professor of chemical engineering. Only the beginning of a large undertaking by the professor, this course was the pioneer for a new curriculum in bio-engineering.

Professor Finn, who instituted the new option at Illinois, was born in Waukesha, Wisconsin, and received his elementary and high school education there. Upon graduation from high school he went on to Cornell University where he obtained his bachelors degree in chemistry and chemical engineering. Being interested in biochemistry,

ROBERT K. FINN

Finn then obtained his masters degree doing much work in bacteriology.

During the war years and immediately preceding the war he was employed by Merck and Company in Rahway, New Jersey. Much of his time there was spent in the development of the wonder drug, penicillin.

In 1946, Robert Finn began work at the University of Minnesota for his Ph.D. in chemical engineering. Having received his degree he came to teach at the University of Illinois in the fall of 1949. His major assignment was the establishment of the course in bio-engineering.

Because of his intense interest in biochemistry Dr. Finn has little time for hobbies. He does, however, maintain physical agility by playing tennis in the summer and handball in the winter. At present he is attempting to develop improved respiratory methods for microorganisms in fermentation.

Dr. Finn and his wife made a 1,000 *mi.* bicycle tour of some of the European countries last summer. On a suggestion, they hitch-hiked through Britain and then purchased bicycles to complete the tour. Their back-road excursions led them through Holland, Germany, Austria, Switzerland, and some of the other well-known European nations. Thoroughly enjoying themselves, the Finns found Europe both hospitable and beautiful, even in this day of international friction.

Although he is kept busy as the adviser of the U. of I. Student Branch of the American Institute of Chemical Engineers, Finn still finds time to devote to other organizations. Currently he is a member of the American Chemical Society, the Society of American Bacteriologists, and the honorary fraternities Phi Lambda Epsilon and Sigma Xi. Being the adviser of the Student Branch he is also, of course, a member of the AIChE.

•

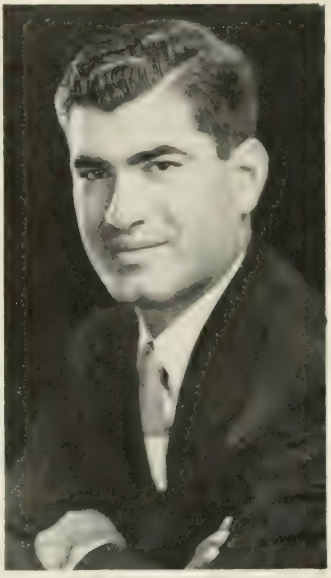
MISHAL HAMMODAT

Mishal Hammodat, vice president of the Engineering Council, is gaining experience in diplomatic "bridge" building through his activities on the Council this semester. "The Bridge" that Mishal is interested in is not the kind civil engineers usually think about, however. It's the name of the house for University of Illinois engineering students to be sponsored next fall by the Council's international student activities committee, of which Mishal is chairman. Half the residents of the house will be American students and the other half will be foreign students. Their common purpose will be to bridge the gap between the engineering students of the world.

Mishal was born in Mosul, Iraq, and graduated from the Mosul secondary school in June, 1948. Competing with students from all over his country, Mishal was one of about 100 students chosen by Iraq's minister of education to come to this country to study the petroleum production option in mechanical engineering.

Before leaving for the United States, Mishal was sent for a year to a preparatory school at Baghdad to master the English language, which he has managed to do. In July, 1949, he left Iraq and arrived here to enroll at Illinois.

Although he is carrying a heavy schedule this semester in order to get both his B.S. and M.S. in June of '53, he has numerous activities along with his Engineering Council work. He is a member of ASME, Pi Tau Sigma, the honorary fraternity for mechanical engi-



MISHAL HAMMODAT

neers, and is the treasurer of the Moslem Student Association.

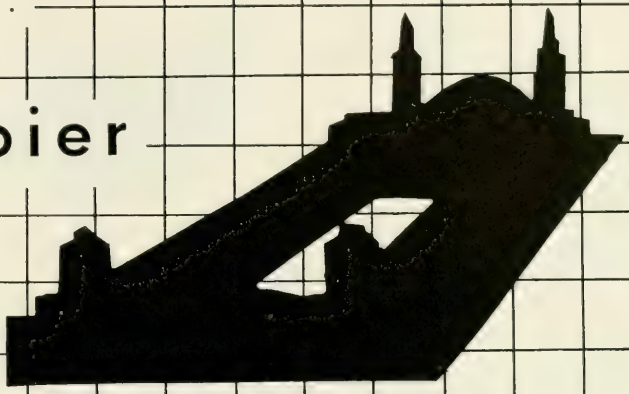
Mishal is an ardent traveler and during the holidays has visited 32 different states. He hopes to see the remaining ones before returning to Iraq. As for sports, basketball and swimming are his favorites. He is also very interested in square dancing which he picked up in this country. His taste in music leans heavily in favor of the classics.

Mishal says that the Iraq government will have spent about $15,000 on his engineering training by the time he graduates. According to his contract, he will return to Iraq after graduation to

(continued on page 32)

— the university of illinois at . . .

navy pier



by Melvin H. Beckman, arch.e. '55

PIER IN THE PUDDLE

The first shelter man ever had was probably the branch of a tree, hurriedly taken advantage of during the first inclement weather in the Garden of Eden. Through the history of man since that time, he has been improving on and adding to this simple shelter until we now sometimes wonder whether or not Adam's idea wasn't better than ours.

One may drive through the most exclusive neighborhoods and find house after house consisting of wildly distorted and ill-proportioned abstractions of Adam's first shelter, the tree, combined with illogical and uneconomic use of stone, brick, glass, metal, and imitations of these and other materials of nature, the use of which often depends to a large extent upon the whim of the owner.

The owner's uneducated viewpoint in architectural matters is the main reason for most of the ridiculous architecture one is forced to endure during his daily activity. Men do not dream of advising a competent doctor on the correct procedure to cure a disease. Moreover, most people listen to and heed the advice of lawyers, bankers, insurance men, and their like when their individual talents are required.

But when a man decides to build a house, does he seek the same professional advice that he would if he were about to undergo extensive surgery? Very seldom. Oh, yes, he may go to an architect, but only as a matter of necessity, since in few places can one get a permit to build without an architect's seal on the plans of a prospective structure. However, the owner comes loaded down with magazines dealing with every type of confused, monstrosity he can find. He expects the architect to whip out a cute house, loaded down with the inevitable fillegre and sand drippings which have cluttered up our darling Cape Cod hovels since we can remember. No doubt this would-be home owner has a few pet ideas of his own to toss in, because after all, this magazine research he has done, he considers himself an authority on architecture and building construction.

Now, very few men get rich as architects, and as a consequence most architects will listen patiently to this man's asinine suggestions, and then provide him with the desired set of drawings, which is a combination of ideas between various feature writers, the owner's whims, the owner's friends opinions, and finally the architect's attempt at a satisfying solution. The result is obvious: an awkward, uninspired dwelling which dominates what is laughingly called our progressive civilization.

Significantly, the only homes which are truly outstanding functionally and aesthetically are being designed by men who refuse to accept these magazine-owner combines, and instead inspect the owner's problems as a new and unique situation, and then set out to give him exactly what he needs, as economically and logically as possible. Anyone who sets foot in homes designed by men like Frank Lloyd Wright, Pietro Belluschi, Walter Gropius, Bruce Goff and others of this calibre, is struck by the functional beauty of these dwellings, and anyone who has been fortunate to own or live in one will never accept anything of lower standard.

If the public would approach architects in the same way it approaches other professional men; that is, ready to listen to a logical solution of its individual problems of everyday living, they would have more pleasing and beautiful homes; even more beautiful than they realize.

Above all, through more pleasant and stimulating environments, people would live more normal and useful lives, permitting them through greater functional efficiency to devote more time and talent to restoring peaceful normalcy to the other phases of life in our disturbed, chaotic world!

ENGINEERING SOCIETIES

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

The American Institute of Chemical Engineers Student Chapter at the Navy Pier Branch of the University of Illinois was privileged to have Doctor Otto Eisenschmil speak to them at a recent meeting.

Doctor Eisenschmil is a well-known chemist in the field of paint chemistry, and is chairman of the board of the Scientific Oil Compounding Company of Chicago. Among his achievements are numerous articles for technical publications and several books. One of his better known works, *Without Fame*, is

(continued on page 34)

Atomic Powered Aircraft

Below is the text of an address by Dr. M. C. Leverett, of General Electric's Aircraft Nuclear Propulsion Project delivered before the Chicago Section of the Institute of the Aeronautical Sciences. Because the editors feel that this article is of such vital importance, we have included it here.

Introduction

A discussion of the interesting subject of propulsion of aircraft by nuclear power is unfortunately considerably restricted by Security. My task in making this talk is, therefore, not an easy one, and if I omit to say exactly how some of the interesting problems which I shall tell you about may be solved, it will be understood that this is unwise at present. There is, of course, the chance that in following this line I shall be credited with knowing the answers to many more problems than actually have been solved, and I hope that should you later discover that we who are working in this field have made more or less progress than you assume from my present remarks that you will not feel that I have intentionally misled you.

In spite of the restrictions placed upon our discussion we can discuss in fairly free fashion the principles underlying nuclear powered flight, some possible methods of achieving it, and some problems which are involved. Before starting this discussion, however, we should pause a moment to answer the question, "Why do we want to fly an aircraft on nuclear power?"

Many years ago Breguet set down the formula which bears his name and which states that the range of an aircraft is proportional to its lift-to-drag ratio, to the efficiency with which its propulsive system works and inversely proportional to the weight of fuel consumed per unit of work delivered to the propulsive system. Any decrease in the specific fuel consumption obviously leads to increased range. Because of the ingenuity of the designers of aircraft and engines the Breguet formula is scarcely of more than academic interest in these days. Devices such as accomplishing most of a flight slowly and using high speed only at critical times, refueling in flight, and discarding not only the fuel tanks but also the lifting surfaces which support them as soon as they are empty, all have been seriously proposed or practiced and operate greatly to increase the range of modern aircraft. However, it is no deprecation of our heavy bombers, which are the best in the world, to say that even more range would be desirable, particularly if it can be coupled with high speed. This is the point at which the nuclear propelled airplane comes into the picture. One pound of uranium-235 will liberate heat on undergoing fission equivalent to the energy liberated by burning 1,700,000 pounds of gasoline. It is at once evident that if a means can be found for converting the energy of nuclear fission into thrust that aircraft can fly for very long times on very small amounts of fuel. Indeed, fuel consumption would be measured not in thousands of pounds per hour, but in pounds per day. Because of the enormous amounts of energy available from a small amount of fuel, high efficient utilization of this energy would no longer be crucially important. Thus, specific fuel consumption could be allowed to worsen somewhat if this were desirable in order to make some other feature of the power plant easier or better.

Although the basic superiority of nuclear fuel over chemical fuel is thus superficially stated as a simple ratio of 1.7 million to 1, the implications and complications of this fact are extremely varied and far reaching. For example, some of the implications may be listed. A nuclear aircraft could encircle the globe many times without stopping, although this particular maneuver would be more dramatic than useful. It could fly entirely around the world at local midnight, accomplishing the entire circuit in darkness and with the lower vulnerability which night flying confers. Careful husbanding of fuel, programming of flight speed and altitude, and closely timed flight plans would become unnecessary in a nuclear powered airplane. Such an airplane could fly at its maximum speed and at any altitude over its operating range for all or any part of its mission and still be perfectly sure of having enough fuel to return to its home base by any route whatever. A nuclear powered aircraft could possibly stay aloft for many days. It would be limited only by the freedom of the air craft and power plant from breakdown and by the ability of the crew to endure long hours of flight and exposure to nuclear radiation. It is clear that many missions which are impossible for chemical aircraft would be possible with nuclear powered aircraft.

Principles and Suggested Methods

One of the basic principles of nuclear energy is that the energy of fission is manifested as heat. That is, a nuclear reactor is primarily a source of heat which must be converted into thrust or into mechanical work in more or less conventional ways. Hence, in any nuclear power plant whether it is for an aircraft, a naval vessel or for the generation of electricity on the ground there will be a reactor and heat machinery. In the aircraft the heat machinery is the propulsion system. Secondarily, and somewhat unpleasantly, the reactor is a source of radioactivity; hence, there will also be a shield of some type or other.

Propulsion Machinery

There is scarcely a single type of aircraft propulsion machinery which has not been proposed for incorporation in a nuclear power plant for aircraft. One obvious proposal is that propellers be used, driven by turbines which are in turn run by expanding through them vapor such as steam, heated in the reactor or air heated in the reactor. A variation of this scheme would be to extract the heat from the reactor by some liquid coolant other than the vapor or air and transferred to the vapor or air in an external heat exchanger or boiler. Another fairly obvious proposal is that the reactor should directly or indirectly take the place of the combustion chambers of a conventional turbojet engine. Here again, the heat might be extracted from the reactor directly by the air or indirectly by other coolants, such as liquid metals, and transferred to the air outside the reactor. Ducted fans driven by turbines, operated in turn by vapor or air heated in the reactor, have been suggested. Obviously, the reactor might also take the place of the combustion apparatus in a ram-jet propulsion system. It has also been proposed that a compressor-jet type of propulsion system be used, with the compressor driven by vapor or hot air

(continued on page 30)

THE FUTURE OF THE YOUNG ENGINEER at Western Electric is limited only by his own ability, by his vision to see what lies ahead and by his capacity to work for the goal he sets himself. Recent developments such as microwave radio relay networks for telephone calls and television programs – operator and customer dialing of long distance calls – automatic message accounting – new secret electronic equipment for the Armed Forces – promise an ever widening field for him.

MANY ENGINEERING TALENTS ARE REQUIRED. Most are used in creating plans, machines and technological methods to convert raw materials into thousands of different precisely manufactured articles. Here at Western, the engineer translates the stream of new designs from Bell Telephone Laboratories into terms of practical production. It is his job – a fascinating and satisfying one – to provide the ways and means of reproducing the laboratory model, as economically as possible, in whatever quantity the Bell Telephone System needs. And even after production is rolling, his efforts are unceasing in the search for improved methods, tools and materials which will result in a better product or a lower unit cost.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

by Bob Schrader, ch.e. '54

OUTSTANDING SENIOR CIVILS TO RECEIVE AWARD

The annual award of the Ira O. Baker Prize given to two outstanding senior civil engineering students will be presented at a convocation on May 7.

The award was established in 1923 by Dr. Baker who served forty years as head of the UI civil engineering department. Dr. Baker, an eminent educator and engineer felt that the student who had done well scholastically, and had participated in the activities of the professional civil engineering society and on student technical publications should be rewarded in his department. He set down the following qualifications for the awards:

1. A good scholastic standing in the junior and senior years.

2. Authorship of technical articles or association editorially with the college technical journals.

3. Participation in the American Society of Civil Engineers student organization or a similar group.

4. Possession of pleasing personal characteristics, executive ability, promise of leadership, etc.

It has been the practice to invite a student of Dr. Baker as the convocation speaker, and this year Mr. A. L. Kuehn, president of the American Creosoting Company, Louisville, Kentucky, will deliver the address.

Numbered among past recipients of the award are several men now serving prominently in industry and in education as heads of civil engineering departments at various colleges throughout the United States. At the University of Illinois instructors who received the award during their student days are Robert J. Mosborg and John Rice Leek.

* * *

"A professor who comes in late is rare; in fact, he is in a class by himself."

One of the largest groups of subscribers to the *Tech* is composed of the high schools of Illinois. Along about this time of the year many seniors at these schools are thinking about college, and we hope that quite a few are interested in engineering. It is with you prospective engineering college freshmen that this section of the *Bilge* is concerned. To give you an idea of what kind of work you will be doing in engineering school, we have set down a hasty list of the courses you will be taking in engineering at Illinois.

A very large number of courses are common to almost all branches of engineering. These include a year of chemistry, a year of engineering drawing, a year of rhetoric, mathematics through integral calculus, a year of physics, some courses in theoretical and applied mechanics, and an introduction to electrical engineering.

Aeronautical engineering trains students in the basic principles of airframe and aircraft power plant design. Special study is given to aerodynamics, aircraft structures, aircraft power plants, design, and production.

Agricultural engineering includes the basic engineering courses, as well as fundamental ag courses. Two options are offered: one in machinery and power, and the other in farm structures and soil and water conservation.

Courses in ceramic engineering deal with the general scientific principles underlying the ceramic industries. These industries include the manufacture of brick, tile, pottery, glass, porcelain enamels, abrasives, and cements.

Chemical engineering prepares students to evaluate laboratory results and to translate them into large scale commercial processes, to improve existing plants, to develop new products, and to operate and supervise chemical plants.

Civil engineering offers training in the principles underlying civil design and construction. Construction, highway, hydraulics, railway, and structural options are available to civils in their senior year. A curriculum in sanitary engineering also closely parallels the civil engineering curriculum.

Electrical engineering prepares men for responsible positions in research, development, design, operation, communication and electronics, and illumination.

General engineering gives students a sound education in engineering principles with basic work in industrial organization and administration.

Mechanical engineering offers a wide variety of optional curricula in the third and fourth years. There are options in aeronautics, air conditioning and refrigeration, petroleum, power, production, design, research, and railway.

Metallurgical engineering covers chemical, physical and mechanical metallurgy, with emphasis placed on physical metallurgy.

Mining engineering gives instruction in the fundamental problems dealing with extracting coal and minerals from the earth. Specialized courses in mine surveying, mining methods, etc., are given.

The first two years of the engineering physics curriculum are much like the other engineering courses, while the third and fourth years emphasize advanced courses in physics, math, and chemistry.

* * *

The talents of engineers on this campus cover an almost unlimited range. They vary from playing football in the Rose Bowl to playing the bass viol in the University symphony orchestra. But probably one of the most versatile of the "slide-rules" is Don Sokolis, a chem engineer. Don recently paced the Illinois three rail billiard team to second place in the National Intercollegiate Billiard tourney. How about it, can you top this?

Power at your finger tip

Nearly everything you do today is done easier, quicker and better—thanks to electricity

If you are an average American worker you use the strength of nine horses each working hour of the day.

WHERE DO YOU GET SUCH POWER—Merely by flicking a switch . . . for by that simple act you are tapping the vast sources of electric energy that are ready to work for all of us in the home and on the job.

Today, the use of electric power has grown to where a single factory uses more electricity than an entire city used a generation ago. And your home—with its electric appliances, lighting and other conveniences—consumes more power than was used in yesterday's factory.

NEW MATERIALS WERE NEEDED—This great progress could not have been achieved without the many new and better materials which make possible today's larger and more efficient power generating equipment.

A JOB FOR ALLOY STEEL—Giant turbines and generators, for example, couldn't stand up under terrific heat, pressure, wear and corrosion if it weren't for steels made tough and enduring by alloying metals.

Improved plastics also do their part in better insulation and protective coatings. And carbon brushes are as vital to huge generators as they are to your vacuum cleaner motor.

FOR MORE POWER—Developing and producing alloys, plastics, carbons and many other better materials for our power industry are but a few of the many ways in which the people of Union Carbide serve all of us.

STUDENTS and STUDENT ADVISERS

Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of ALLOYS, CARBONS, CHEMICALS, GASES, and PLASTICS. *Ask for booklet A-2.*

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engineers unbend at . . .

Saint Pat's Ball

by Bob Schrader, ch.e. '54

The luck of the Irish was with the Illini this year for the Engineer's Week end. Held in the season of the year when storms are the rule, rather than the exception, the Open House was blessed with two days of perfect weather. Still following a path strewn with four leaf clovers, the engineers and their dates attended a fine St. Pat's ball on Saturday night.

The St. Pat's ball was quite a success, with engineering and liberal arts alike all enjoying the dance. Ralph Marterie and his orchestra played for the ball, and they repeated the sterling performance they had given for the Registration Dance here at Illinois last fall. Another feature of the dance was the exhibits presented by the different engineering societies. A miniature railroad bridge, the kissometer, ghost-writing, a quizzmaster for people who wanted to be stumped by the ag engineers, a display of clever gears by the mechanical engineers, and many other exhibits entertained the visitors.

Highlighting the ball were the ceremonies at intermission. Professor A. R. "Buck" Knight of electrical engineering was the master of ceremonies. He introduced St. Pat, himself, in the presence of C. Dale Greffe, associate professor of mechanical engineering. This was Greffe's second year in the role of St. Pat. Trophies then were presented to ASME for the best float in the parade and to the GED department for having the best Open House exhibit.

Dean Everitt of the college of engineering was introduced and he presented awards to the twelve men who were chosen as Knights of St. Pat. Each of the engineering societies nominates men for the honor, and the final selection of the Knights is made by the engineering council. The men selected are:

Hank Kalapaca, *The Illinois Technograph*
Bill Greenfield, IAS
John Schultz, SBACS
George Ratkovic, AIChE
Dave Harris, ASAE
Don Falk, AIEE-IRE
Jorge Quiros, MIS
Phil Trimble, AIEE-IRE
John Huber, ASAE
John Jombock, ASCE
Bob Johnson, IAS
Ralph Herrick, ASME

W. L. Everitt, dean of college of engineering, knights John Huber. (Photo by Richard Bobbe).

The high point of the intermission marked the end of a story about a door prize. The story began about two weeks before the ball when the St. Pat's committee was wondering what to give for a door prize. They finally decided to give a door. They obtained a door, painted various engineering formulas on it, and placed it in the window of the Illini Union book store.

On the Friday before the dance, a group of would-be photographers entered the book store, telling the manager that they were from the *Technograph*.

(continued on page 26)

Left: The orchestra of Ralph Marterie plays for the enjoyment of the engineers at the St. Pat's Ball. Right: Members of SDX, journalism fraternity, return "door prize" stolen from Union Bookstore window. Later the engineers returned a door taken in retalliation from The Daily Illini. (Photos by Ed Wojtas).

WIRE ROPE

This is the most economical rope we've ever made for construction equipment

ROEBLING is the best known name in wire rope. That's partly because we were the first wire rope maker in America. But more than that, we've always led in developing better wire and better rope for every purpose.

Today's Roebling Preformed "Blue Center" Steel Wire Rope is the best choice for efficiency and long life on excavating and construction equipment. This rope has extra resistance to crushing and abrasion . . . stands up under rough going. It saves time and cuts costs.

There's a Roebling wire rope of the right specification for top service on any job. And Roebling Field Men are always showing users new economies through proper operation and maintenance. John A. Roebling's Sons Co., Trenton 2, N. J.

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skimming industrial headlines

edited by Charles LaRobadier, m.e. '55

New York ferries radar-equipped

Three of New York's newest ferries now feature dual console installation of marine radar equipment. Because the 200-foot vessels must operate with equal ease in either direction, each wheelhouse is equipped with a radar console alongside its wheel. The equipment, manufactured by Westinghouse, will provide a continuous chart of the entire harbor as the boats ply the heavy-traffic route between South Ferry and Staten Island, crossing the main channel through which inbound and outbound ocean traffic operates from the North and East River piers.

Both consoles will receive signals from the same antenna mounted on the top deck. Instantly adjustable, the equipment is capable of distances of one, two, four or eight nautical miles.

The 3,000-passenger ships' other features include turbine-generators, battery-charging rectifiers, Micarta plastic rudder bearings, and fluorescent lighting.

spring fatigue

Are your auto springs tired? It has been known for 100 years or so that steel, and all other metals, suffer fatigue if they are repeatedly put under stress. Steel can carry a big load, but when it must carry even a relatively small load time after time, it may eventually give way.

Ever since the German metallurgist, August Wohler, tested fatigue failures on railroad axles in 1852, steelmen have been looking for the secrets of endurance in steel. These secrets are very hard to get at. Just as the resistance of people to fatigue often seems unrelated to their physique, so steel's endurance seems to be largely independent of other properties of the steel.

Steelmen do know, however, that high tensile strength in a piece of steel reduces its fatigue. So they have used the things that build up tensile strength—cold rolling and heat treating—to build up steel's endurance.

Various kinds of steel are continually being worn to a frazzle in research tests, so that their limits of endurance will be accurately known before they are placed in service.

A typical specimen of steel may take anywhere from 500,000 to 10,000,000 stretchings, or squeezings, or vibrations in one experimental session—only to go through the whole process several dozen more times while researchers vary the severity of the test.

It may take weeks before the endurance limits are known, but that's still quicker than observing a part in actual operation, such as following an active automobile spring around—awaiting its ultimate demise upon the *n*th chuckhole.

Short-wave dispatcher recording information and controlling intraplant truck shipments. (Courtesy of Westinghouse).

short wave radio truck dispatching

The installment of short wave sets in trucks has greatly speeded up and organized intraplant shipments at Westinghouse.

From a centrally located dispatching office any industrial truck operator in the plant can be given shipment orders along with all essential information as to the most easily accessible storeroom containing the proper quantities of the materials to be moved.

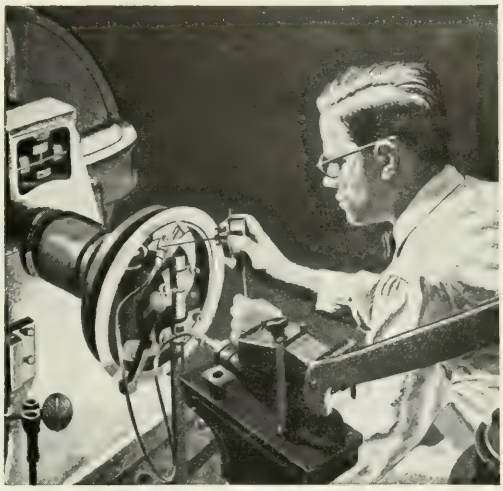
One dispatcher handles the entire

(continued on page 42)

Radar-equipped New York ferry crossing harbor between South Ferry and Staten Island. (Courtesy of Westinghouse).

Opportunities at General Motors

What the GM Organizational Setup Offers You—the Graduate Engineer



To understand your opportunity at General Motors you need to understand the General Motors setup.

GM is not only a major producer of motorcars and trucks. It is also a leading manufacturer of many types of civilian goods from heating systems to refrigerators, from fractional h.p. motors to Diesel locomotives.

And, as a top defense contractor, GM is building everything from rockets and shells to tanks and jet and Turbo-Prop engines.

In these many operations we require the services of all types of engineers, engaged in all phases of engineering work—from pure research to production supervision.

This work is decentralized among GM's 34 manufacturing divisions, operating 112 plants in 54 towns and cities throughout the country. Each division operates as an independent unit with its own engineering department. Yet each benefits from the resources of GM's central research and engineering laboratories.

So, from the start, GM offers the engineering graduate both the opportunities and facilities of a large successful organization, and the friendly working environment of a smaller company.

It is well, too, to note that a high percentage of engineering school graduates, through hard work and initiative, have made sound business careers for themselves at GM. In fact, today, many GM divisional managers are engineering school graduates. And so are many others in top management.

For further information on a GM engineering career, we suggest you ask your College Placement Office to arrange an interview for you with the GM College Representative the next time he visits your campus.

GM POSITIONS NOW AVAILABLE IN THESE FIELDS:

Mechanical Engineering • Electrical Engineering
Metallurgical Engineering • Industrial Engineering
Chemical Engineering

See December 1951 issue of Fortune Magazine for description of new multimillion dollar GM Research and Technical Center in Detroit.

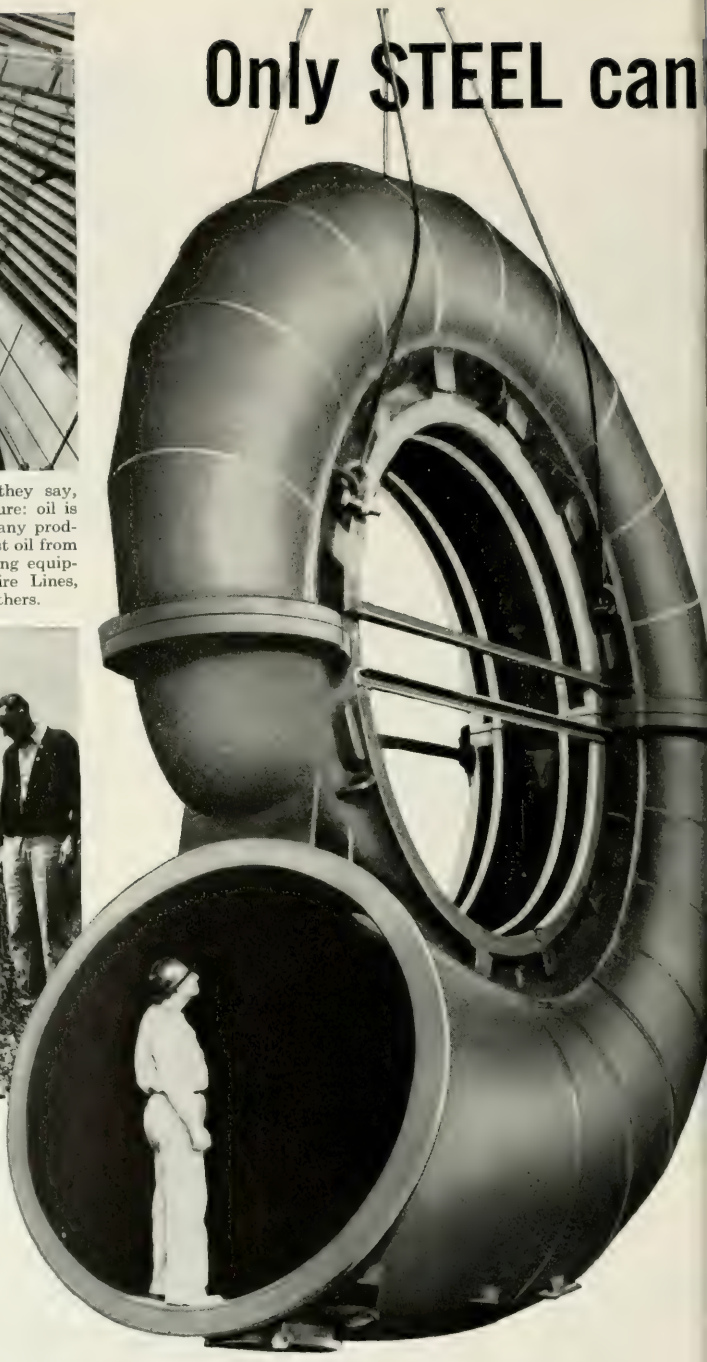
GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan

Only STEEL can

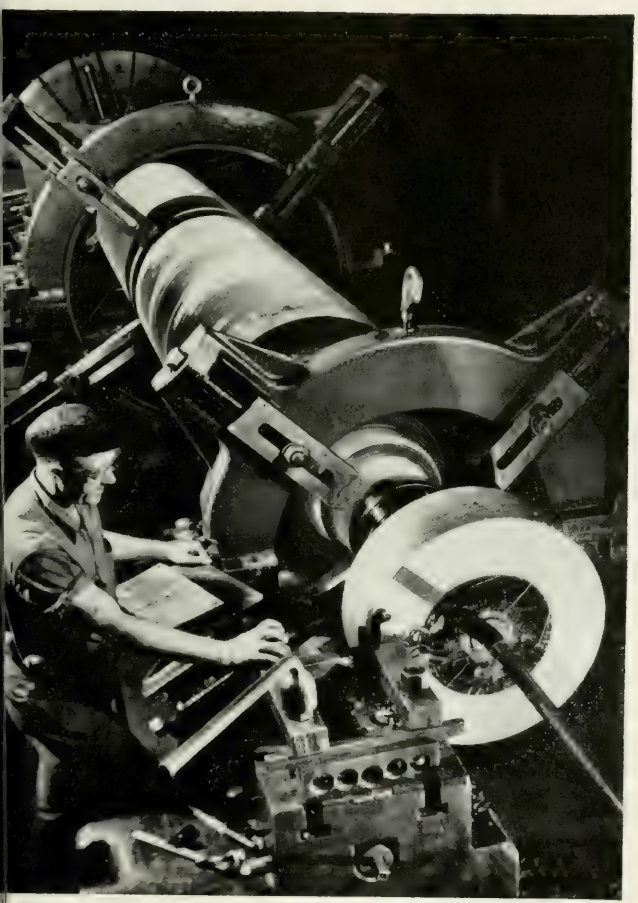
OIL WILL SHAPE THE FUTURE of mankind, they say, which may be true. But one thing is sure: oil is essential to our *present* security. And many products of U.S. Steel are widely used to wrest oil from the earth: "Oilwell" drilling and pumping equipment, National Pipe, Tiger Brand Wire Lines, Universal Atlas Cement, and a host of others.

WHAT HAS A STEEL MILL to do with soil conditioning? A lot. For some of the products of steel-making are ideal for agricultural use. For example, many southern farmers use Tennessee Basic Slag to add phosphorus and lime to the soil, stimulate luxurious crops. Look at the picture: at left, test crop of crimson clover and barley grown on badly eroded land conditioned with Basic Slag; at right, result of same planting without Basic Slag.



MAN SIZE! When you can step into its mouth and look down its throat like this, you've got a scroll casing for a hydroelectric turbine that's really *big!* This one, of welded steel construction, has a 98-inch inlet, a 132-inch bore. It's made by United States Steel.

lo so many jobs so well



WHOPPER. This 96-inch lathe in the Homestead District Works of U.S. Steel can turn and bore a 110-ton piece of steel that's 8 feet in diameter and 66 feet long! But to produce quality forgings, it takes fine steel and skilled craftsmen, as well as modern machines. United States Steel has all three.

THE DEFENSE PROGRAM calls for steel and more steel . . . for weapons, ships, planes, even lowly barbed wire like this. Only steel can do so many jobs so well. And fortunately, United States Steel and the more than 200 other steel companies in America are able to produce enormous quantities of this vital metal . . . more than all the rest of the world put together.

ACTS YOU SHOULD KNOW ABOUT STEEL. In making the products that are sold under the United States Steel trade-mark, U.S. Steel buys materials from nearly 54,000 *other* companies . . . and over 40% of all money received by U.S. Steel for its products is paid out to these suppliers.

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This trade-mark is your guide to quality steel

. . . The Theatre Guild on the Air, presented every Sunday evening by United States Steel. National Broadcasting Company, coast-to-coast network. Consult your newspaper for time and station.

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BIG CATS . . .

(continued from page 7)

from the oil vapors by gravity and drops into the spent catalyst standpipe and through an automatically controlled slide valve to the air injection point. Here its density is reduced from 25 lb cu. ft. by a current of air which "fluffs up" the catalyst making it flow as a fluid up the regenerator return line.

The oxygen in the air admitted for "fluffing up" purposes continuously regenerates the catalyst by burning off coke. This action brings the catalyst to a temperature of about 1100 F. and makes it an effective heat-transfer medium for vaporizing the fresh-oil feed and supplying the heat necessary for the cracking reaction. The reactivated hot catalyst is retained in the regenerator and is constantly withdrawn into the standpipe for re-use.

The combustion gases pass through cyclone separators in the top of the regenerator where they follow a high-velocity spiral path which throws the heavier catalyst particles to the outside of the separator by centrifugal force. The recovered catalyst is returned to the bed while the flue gases enter the regenerator exit line and pass through the flue-gas cooler where their contained heat is used to generate high-pressure steam by heat exchange with water. The cooled flue gases then pass to the electrical precipitator which has a 55,000 volt potential between plates. Most of the catalyst is recovered and the flue gases are vented to the atmosphere. Recovered catalyst passes from the precipitator into the recovered catalyst line and is blown into the regenerator.

The combined hydrocarbon gases from the spent-catalyst is recovered and returned to the main bed. The cracked gases pass through the reactor overhead line to the fractionator scrubbing section where the small quantity of resicual catalyst fines is diverted to the bottom of the fractionator and passes with heaviest oil to the slurry settler, an integral part of the fractionator in which the catalyst settles out by gravity. The clarified decanted oil is withdrawn from the top of the settler for use as fuel oil or for further processing. The thickened catalyst slurry passes into the catalyst return line and is returned to the reactor. This completes the circuit of catalyst in the system.

The vapor stream entering the fractionator passes upward from the scrubbing section through the bubble plates of the fractionator and usually is separated into wet gases, unstabilized gasoline, light gas oil, and heavy gas oil. The heavy gas oil, or the entire fractionator side stream can be diverted for a recycling operation to the recycle-oil line and so returned to the reactor for further cracking with the fresh feed, if it is economically feasible to do so.

It is hoped that some insight has been gained in the operation of this new giant of the petroleum industry. It is probable that within a few years, most gasoline used in this country will be produced by catalytic processes. With knowledge gained from experimentation and experience, the proper catalysts may be found that will produce a myriad of other products. Even now, in Brownsville, Texas, the catalytic process is being run "backward" to produce gasoline and other products from natural methane gas. Although there is no reason for doing so, even "crude" petroleum can be made from natural gas by using the proper catalysts. Catalytic processes are truly a new "magic wand" in the American petroleum industry.

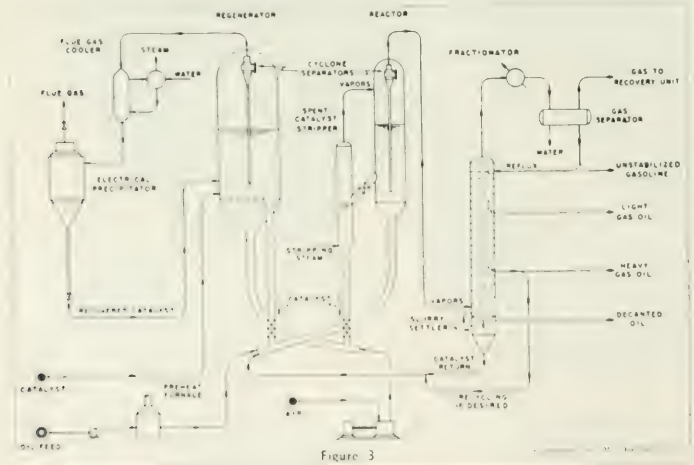


Figure 3

ST. PAT'S BALL . . .

(continued from page 20)

As soon as the manager turned his back, they calmly picked up the door and walked off with it.

The engineers were out after the culprits as soon as they heard about the theft, but they were too late. No trace of the door could be found. Members of Sigma Delta Chi, honorary professional journalism fraternity, were suspected of having a great deal to do with the disappearance of the door, but nothing could be proved. The question was finally settled Saturday night, as three members of Sigma Delta Chi brought the missing "door prize" to the dance. And so ends the case of the disappearing door prize.

As dancing ended at midnight, a grand Engineer's Weekend came to a close. It was a weekend that not only gave enjoyment to everyone who was here, but also established firmly once again the tradition of Engineering Open House at Illinois.

A new phase of atomic research will be opened up at the University when the department of sanitary engineering begins a study of the problem of the presence of radioactive substances in water supplies, in sewage, and in the disposal of industrial wastes.

Knowledge of these effects must be obtained before the increasing load of radioactive materials reaches alarming proportions.

Put yourself in the position of the prisoner who was given 10 white balls, 10 black balls, and 2 boxes. He was told that the executioner would draw 1 ball from 1 of the 2 boxes. If it was white, the prisoner would go free, if it was black, no head. How would you arrange the balls in the boxes to give yourself the best odds for survival? Answer next issue.

It had been a busy day for mother and to make matters worse her small son came running into the house with his pants torn.

"You go right to your room and mend those pants yourself," she ordered, "and don't let me see you out here until the job is done."

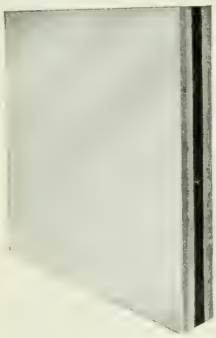
A little later she went in to see how the job was coming along. The pants lay on a chair and the door to the cellar, usually closed, was open. The mother called down sternly: "Are you running around down there without your pants on?" A deep voice answered, "No ma'am. I'm reading the gas meter."

What's Happening at CRUCIBLE

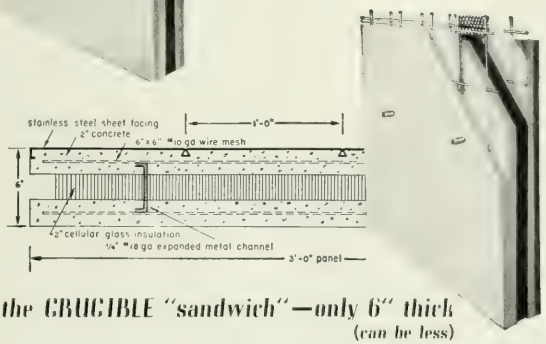
about stainless curtain walls

Modern construction methods have changed walls from the self-supporting type to a mere covering which does not support its own weight for more than one or two stories. Hence the definition of "curtain wall":—the facing or enclosure of the structural steel frame. This frame supports the entire weight of modern buildings.

The need has existed for a covering that would not only clothe the building, but be lightweight, economical and space saving. Because these requirements are more than adequately met with stainless steel curtain wall construction, this method is becoming increasingly popular with cost and space conscious owners, builders and architects.



the CRUCIBLE "sandwich"



the CRUCIBLE "sandwich"—only 6" thick

(can be less)

Crucible stainless steel curtain wall panels are in the form of 6-inch thick "sandwiches". The facing consists of flanged, light-gauge stainless steel sheets with a factory, or site-fabricated, sandwich consisting of cellular glass insulation between two layers of concrete with connecting reinforcing. Crucible 18-8 stainless as the outside face offers excellent resistance to weather and fire while providing eternal beauty with a minimum of maintenance; the inside face can be finished or painted to suit the requirements of modern building interiors. Since 18-8 is restricted in use, a good substitute material, type 430 stainless, now government decontrolled, offers the same benefits as 18-8 stainless.

moisture penetration

The unique characteristics of the cellular glass insulation stop moisture vapor migration from one face of the panel to the other. The cellular insulation properly designed and installed assures that condensation will not take place *anywhere* within the sandwich.

insulation

Although less than half as thick as the usual wall construction, this Crucible stainless steel panel construction has more than twice the insulating value. The "U" value (overall thermal conductivity) is approximately 0.15 BTU Hr./Sq.Ft./°F.

fire resistance

The Crucible sandwich met the requirements of a standard 4-hour fire test conducted in the testing laboratories of the National Bureau of Standards. This meets all old building codes and is double, or better, the requirements of modern enlightened building codes.

erection and fabrication

Since a building frame is not precision built, the attachment of the panel walls to the frame is done with fastening devices that provide necessary 3-dimensional adjustment. Panels can be made at the building site, and a 24-hour casting-to-fastening cycle is possible.

technical service available

Though the use of some stainless steel is now restricted, Crucible metallurgists and development personnel are continuing to investigate improved methods of curtain wall and other construction so that better buildings can be built when stainless is more freely available. For more information write: Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Penna.

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CHEM E . . .

(continued from page 11)

this that the chemical engineer translates test tube results into the working model of commercial operation.

The unit process laboratory occupies portions of the first and second floors. It also has two steel mezzanines as well as the two regular floor levels. Much of the space in this laboratory is used for projects and senior research of individual students.

The largest laboratory in the building is the unit operations laboratory. It extends from the ground floor up through the second floor. Its overall size is about 58 by 56 feet. There are three balconies at nine-foot levels, providing four operating levels. There is also a twelve-foot crane-bay. Some of the equipment in this laboratory is a six-plate distilling column, a four-plate distilling column, a double effect evaporator, an ammonia absorption column, filtration equipment, and apparatus for studying flow of fluids.

The research laboratories are constructed so that each one is next to an office. Each laboratory has two doors and emergency shower heads for the safety of the research worker. At present, a great deal of research is being done on aerosols and heat and mass transfer at high pressures.

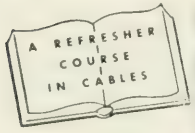
The two foremost men in chemical engineering at Illinois in the past were Professors William Albert Noyes, Senior, and Samuel Wilson Parr. While Doctor Noyes, for whom the main chemistry building was named, was a chemist, his place in the chemical engineer's history is due to his sound judgment in gathering able men to teach at Illinois. The men he brought include Doctor Roger Adams, now head of the department of chemistry, Professor W. C. Rose, and Professor C. S. Marvel, to name only a few.

Professor Parr was the first chemical engineer at Illinois. He started the curriculum and headed the division until his retirement in 1926. He is most famous for his extensive research on Illinois coals. As a result of his work, the classification of coals has been accomplished. He contributed much important information on storing of coal, low temperature coking processes, and use of high sulfur content coals. He developed the Parr calorimeter, by which the heating value of coal is measured, and many other analytical instruments and devices used in the fuel industry. His work was not confined solely to fuels however. His contribution to boiler water treatment is still considered outstanding. He developed the non-corroding alloy Illium. It is fitting that the East Chemistry building has been dedicated to the man who did most for chemical engineering at Illinois.

If one were to look for the present head of the division of chemical engineering, he might have a hard time finding Doctor H. F. Johnstone in his office. One of the busiest men on campus, Doctor Johnstone not only teaches chemical engineering, but practices it as well. It is not uncommon for him to be in his office on Monday, in Washington on Tuesday, and back on campus again on Wednesday.

The staff which Doctor Johnstone has gathered is of the same high caliber. Every undergraduate chemical engineering course is taught by a man with a Ph. D. While the degree itself does not make Doctors Drickamer, Peters, Ranz, and Westwater good teachers, it does indicate that they know their subject. It is also important that these men have served in industry as well as in colleges. Still these are only a few of those who help train the chemical engineer. As mentioned before, the chemical engineer needs a very good background in chemistry. For this ground-work, the chemical engineer at Illinois can thank Doctor Roger Adams and his distinguished staff.

While the chemistry student of 1868 was to be found on the baseball diamond, the chemical engineer of today is found in prominent places in the industrial world.



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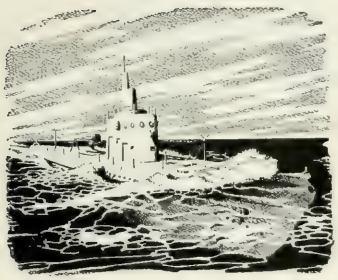

It's a tense moment aboard a U. S. Navy submarine when the signal for diving stations electrifies the crew.

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ATOMIC AIRCRAFT . . .

continued from page 16

from the reactor and the heat supplied to the air by a heat exchanger through which the reactor coolant passes. In all cases, except that of the ram-jet and other direct air cycles, it is required that heat be transported in a coolant from the reactor to the propulsion machinery. In making a choice among the various types of propulsion machinery which have been suggested, the designer must perform detailed and careful analyses of many different possible combinations. Some of the problems which confront him are so obvious that they may be mentioned here. For example, if a propeller type propulsion system is chosen, the hot fluid from the reactor must be piped to the turbines which drive the propellers; these in turn must be mounted on the wings. Thus each propeller must be provided with its own reactor, or hot fluids must be piped around the airplane from a central reactor heat source. Any reactor coolant will undoubtedly become somewhat radioactive in passing through the reactor, and this alternative hence is not attractive. On the otherhand providing each propeller with its own reactor is not easy either, for two reasons. First, the weight of a reactor, with its shield, is very large; more than one reactor and shield therefore is highly undesirable from a weight standpoint. Second, two reactors per airplane would require more than twice the fuel investment of one reactor and a low fuel investment per airplane is desirable, rather than a high one.

Reactor

The design of the reactor will be greatly influenced by the coolant chosen. However, the basic principle upon which the reactor operates is the same regardless of the coolant. This principle is as follows: The reactor may be thought of as a more or less cylindrical body throughout which a fissionable material such as uranium-235 or plutonium-239 is distributed. The reactor also contains passages for the flow of the coolant through it necessary for the removal of the heat and also usually contains a material which is called a *moderator*. The reaction starts with the capture of a neutron by a nucleus of, say uranium-235. Since neutrons are present in small concentration in the atmosphere everywhere, this serves to start the reaction. Immediately after capture of the neutron the U-235 nucleus disintegrates with the liberation of two to three neutrons and 2 atomic nuclei (fission fragments) both smaller than the original nucleus. Most of the energy of fission is carried off by the fission fragments; this energy is imported to the material into which they are cast and appears as heat. Gamma rays and beta rays also are given off in the fission process.

The two to three neutrons given off are ejected into the body of the reactor any may undergo one of three different fates. 1) They may escape from the reactor entirely and be captured outside it by some parasitic nucleus in the structure of the shield or its surroundings. 2) They may be captured by some of the non-fissionable materials in the reactor itself. 3) They may be captured in another U-235 nucleus, following which additional neutrons will be given off. If we can design the reactor so that as many as about 40 per cent of the neutrons given off in fission are captured in other fissionable nuclei in such a way as to cause fission there, the reaction will continue indefinitely until the fissionable nuclei are used up.

The basic problem of reactor design is to reduce to acceptably low values the first two methods of loss of neutrons mentioned above; that is, leakage from and parasitic capture in the reactor. Leakage may be counteracted to some extent by surrounding the reactor with a neutron reflecting material which scatters but does not capture the neutrons. For example, graphite and beryllium oxide are known to be good reflectors. Excessive capture of neutrons in nonfissioning nuclei in the reactor may be avoided by eliminating from the reactor atomic species which have a strong tendency to capture neutrons or, in the language of the nuclear physicist, have a high neutron capture cross section. Unfortunately, it is not always easy to do this because some of the materials which are most suitable for use as reactor structure, and without which the reactor will not support itself, have rather high capture cross sections. These are thus poisons for the nuclear chain reaction although essential for the mechanical stability of the reactor. Obviously, we may increase the fraction of the neutrons which are absorbed in U-235 nuclei by increasing the proportion of U-235 present in the reactor. Unfortunately, this increases the amount of fissionable material invested in the reactor and since fissionable material is extremely precious it is desirable to keep its investment to a low value. We usually, therefore, resort to the device of introducing into the reactor a *moderator*. A *moderator* is an element of low atomic weight and low capture cross section for neutrons. Because of its low atomic weight a neutron striking it loses a relatively large fraction of its energy in each such collision. Because of its low capture cross section, it does not capture many of the neutrons which strike it. After the neutrons are thus slowed down or moderated, their capture by the fissionable material in the reactor becomes much more probable since the cross section for capture of low energy neutrons is higher than that for high energy neutrons. Typical moderators are graphite, ordinary water, heavy water, beryllium and beryllium oxide. The control of the chain reaction is in principle exceedingly simple. One of the most direct means of control is to arrange an absorbing rod so that it can be inserted into the reactor or withdrawn from it. If the rod is withdrawn from the reactor, it will absorb a smaller number of neutrons than before. If, in its original position, the rod was absorbing that number of neutrons which made the reactor just critical, (that is, neither rising nor falling in power) then withdrawal of the rods will create a slight excess of neutrons in the reactor and the power will begin to increase. If, for example, we withdraw the rod so that the fraction of the neutrons absorbed in fission is 0.1 per cent greater than before, then the number of neutrons in the reactor will increase by 0.1 per cent in each neutron generation. Since the neutron generation time is extremely short the reactor will build up fairly rapidly in power in an exponential manner. When it is desired to stop this build up, all that is necessary is to insert the control rod to its original position. This will deprive the neutron cycle of its 0.1 per cent excess and the power of the reactor will stay steady at the new level thus reached. Similarly, if it is desired to decrease the power of the reactor, inserting the rod more deeply than its original position will enable it to absorb more neutrons than before and the chain reaction will gradually die. Other methods of control have been proposed also. For example, in a reactor which has a reflector, removal of part of the reflector will allow the leakage of more neutrons than before. This will decrease the reactivity and constitutes a method of control. Also, removal of part of the moderator or of some of the fuel itself from the reactor will decrease the reactivity, and these expedients may also be used as control mechanisms.

It it is evident that the control of the reactor is an important matter; not so much because of the very remote possibility that the reactor might turn itself into a low grade atomic bomb, but because if the power of the reactor fluctuates without a corresponding fluctuation in the heat removal capacity of the heat transfer system, the reactor inevitably will heat up. Over-heating, if sufficiently severe, can cause accelerated corrosion, warping or even melting of parts of the reactor. Evidently too, it is important that the reactor not be operated without a flow of coolant through it since this certainly will result in seri-

(continued on page 38)

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INTRODUCING . . .

continued from page 14

work ten years in the oil fields for his government.

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PROFESSOR H. F. JOHNSTONE

Professor Johnstone, professor of chemical engineering here at the University of Illinois, is the man responsible for much of the recent progress in the chemical engineering division described elsewhere in this issue of the *Tech*. A native of Georgetown, South Carolina, Dr. Johnstone attended the University of the South at Sewanee, Tennessee and received his B.S. degree there in 1923. He did his graduate work at the University of Iowa, receiving his Ph.D. degree in physical chemistry from that University in 1926.

Upon finishing his college work, Dr. Johnstone assumed a teaching position at the University of Mississippi. Two years later he moved to Champaign-Urbana and became connected with the Engineering Experiment Station at the University of Illinois. Here he entered

PROFESSOR H. F. JOHNSTONE

on a cooperative research program with the Utilities Research Commission of Chicago on a study of stack gas problems related to atmospheric pollution. In 1935, Dr. Johnstone joined the staff of the chemical engineering division and has advanced through the department until today he is head of the department.

Early in the second World War, because of the great demand for chlorine gas and the possibility of an acute shortage of electric power, Dr. Johnstone made a survey for the Office of Production Management on non-electrolytic processes for producing chlorine. Also during the war he directed a munitions development laboratory for the National Defense Research Council in which new munitions for chemical warfare were developed. In reward for this work he received the President's Certificate of Merit and the Naval Ordnance Development Award. Dr. Johnstone is now the chairman of the Research Council for the Chemical Corps Advisory Board, and scientific adviser for the Los Angeles County Air Pollution Control Board. At Illinois he also directs a contract with the Atomic Energy Commission in the Engineering Experiment Station on a fundamental study of aerosols.

Publications by Dr. Johnstone in the field of gas absorption, aerosols and fume problems, and in the production of heavy chemicals are well known throughout the chemical world. When asked about his hobbies, Dr. Johnstone replied that trips to Washington occupy most of his spare time.

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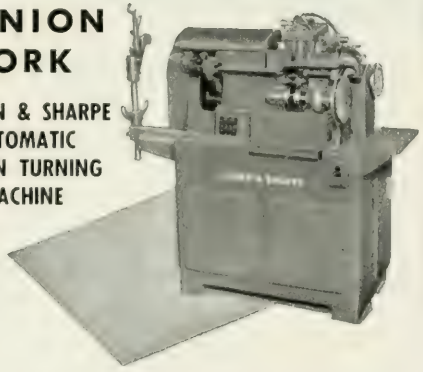

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Gordon R. Finlay, Ph.D., Cornell '42, examines a specimen with the Metallograph in the Physical Testing Laboratory at the Norton electric furnace plant in Chippawa, Canada.

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NAVY PIER . . .

(Continued from page 15)

a book in which Doctor Eisenschmil relates the highlights of 31 years as a chemist and executive. He has been very active in local organizations. Among the positions he has held are the chairmanship of the Chicago section of the American Chemical Society, the presidency of the Chicago Chemists Club, and the chairmanship of the Illinois Commission of the Purity of Paint Material.

As hobbies Doctor Eisenschmil studies criminology and philosophy and is considered an expert on the assassination of Lincoln.

After an introduction by Doctor Hunt, adviser of the Pier Chapter, Doctor Eisenschmil spoke of the problems in the research field. He outlined these problems in three steps:

1. Is the problem worth while?
2. Can the problem be solved?
3. Sell the solved problem.

He stated that there are many men with the ability to solve and sell the problem, but few who are capable of seeing a worth-while problem. Doctor Eisenschmil spoke in an informal manner and often cited incidents from his experiences. The lecture, in general, was highly informative, educational and enjoyable.

In the near future, field trips are going to be made to steel companies in the Chicago area and talks will be given by key men in the diversified fields of chemistry.

The AIChE will demonstrate the rubber-from-oil process at the University Open House which will be held April 23 and 24.

PHYSICS CLUB

During the week of March 17, the Physics Club was host to a member of the Professional Center, who gave an interesting lecture on the betatron. A week later a field trip was made to the Center to see the betatron in operation.

TALK

A general meeting consisting of mechanical, electrical and chemical engineers was held and the manager of the Chicago division of Dow Chemical Company lectured on silicones.

AIEE

On March 4, the chapter was host to a Bell Telephone demonstration of microwaves and later in the month on March 18, Dean F. W. Trezise spoke on *The Manpower Shortage*. April 1 will start off with a movie on the *Electrical Proving Ground*, and on April 29, a field trip to Commonwealth Edison Company to see a demonstration of their circuit analyzer.

AIA

The AIA under a new regime has started a new policy. Ray Bulinski, president of the student chapter, introduced the new system of business meetings on every other meeting and visiting lectures and educational events on the other occasions. A close tie between the student and professional chapters has made this possible. Mr. Harold Reynolds, AIA architect, specializing in interior decorating, delivered the first lecture of the semester on interior decorating.

* * *

On April 23 and 24, from 5 p.m. to 9:30 p.m., the Navy Pier Branch of the University of Illinois will throw open its doors to the public for the 1952 Open House. Everyone is welcome.

A prof of ours went to see the dean and asked him for the day off to celebrate his silver wedding anniversary.

The dean, after some deliberation, said, "All right, but I hope that I'm not going to have to put up with this every 25 years."

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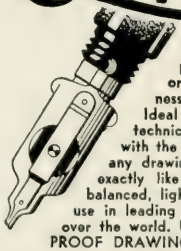

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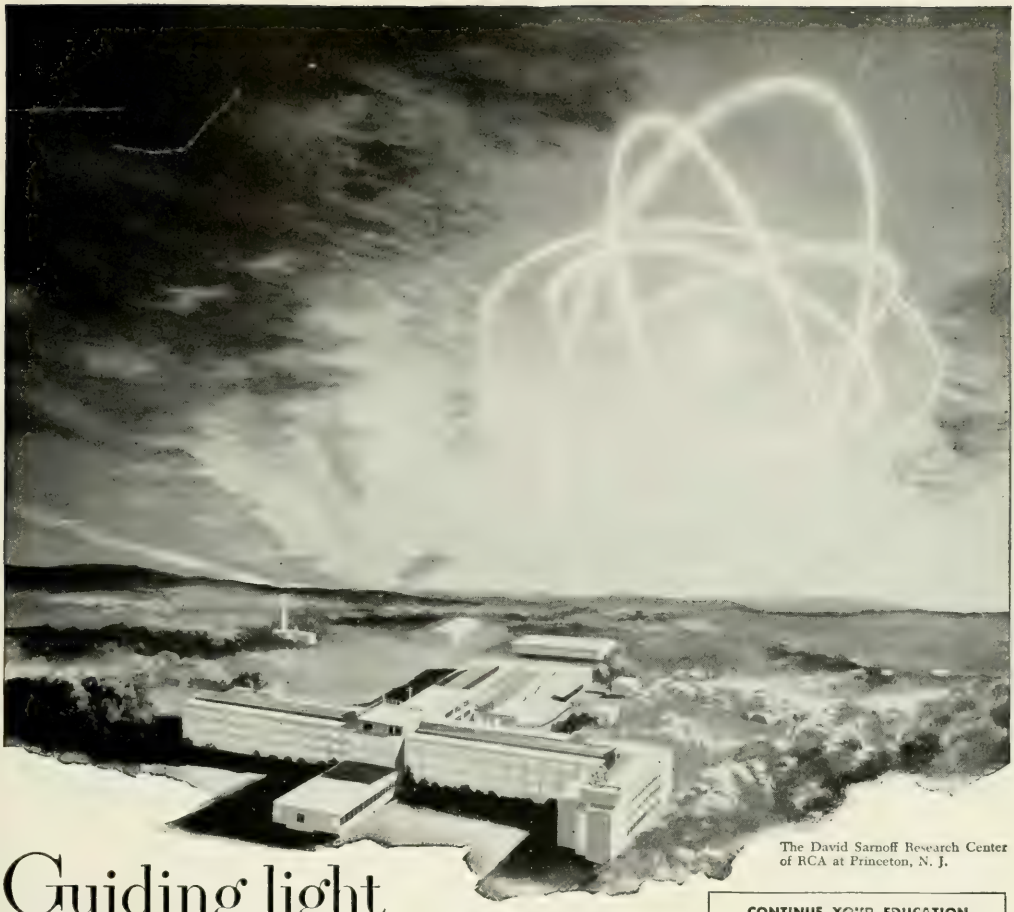

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This is the first official photo of the giant Boeing eight-jet XB-52. It's America's new all-jet heavy bomber, and another trail-blazing product of Boeing engineering leadership. Still highly classified, Boeing's most revolutionary developments are out of sight, under the XB-52's gleaming skin.

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BOEING

ATOMIC AIRCRAFT . . .

(continued from page 30)

ous damage if not destruction of the reactor.

Shield

Although most of the energy of nuclear fission appears as kinetic energy of the two fission fragments mentioned above, and this kinetic energy in turn appears as heat in the fuel elements, a substantial portion of the energy of a reactor appears as kinetic energy of the neutrons and as ionizing radiation, such as gamma rays and beta rays. The neutrons and gamma rays, if allowed to escape with complete freedom from the reactor, would make it necessary for human beings to stay at a distance of more than a mile from a high powered reactor while in operation. Moreover, since the fission products themselves are radioactive and continue to emit gamma rays even after the chain reaction has been stopped, it would not be possible to approach the reactor very much closer than this even after it had been shut down. It is clear that a *shield* must be provided.

The basic requirements of the shield are dictated by the two basic types of radiation which it is desired to stop. The neutrons are slowed down most effectively by light atoms such as hydrogen, and moreover are more easily captured after being slowed down. For this reason an effective shield will contain light atoms such as hydrogen, which also is a good slow neutron absorber. Gamma rays, on the otherhand, are degraded in energy and stopped best by heavy elements such as lead. Hence, the shield normally will contain heavy elements also. It is clear that a mixture of light and heavy elements arranged in the most strategic fashion will be desired. The details of this arrangement are not particularly important for a large stationary reactor such as those which have been built on the ground in the past. However, for a reactor which is to be mobile it is important that the shield weight and dimensions be kept small. Hence, the materials put into the shield must be the best possible and must be arranged in the best possible fashion. The detailed solution of this problem is extremely complicated.

Another point of importance is that not only must the shield prevent escape of radiation from the reactor to the desired degree but also it must be capable of admitting and emitting the coolant which carries the heat away from the reactor. This means that ducts must pierce the shield and we are then confronted with the problem of leakage of radiation through these ducts. Generally speaking, gamma rays and neutrons travel in straight lines. However, under certain conditions they can be scattered or reflected around corners or curves. This confronts us with another difficult but interesting problem in the shield.

Some Problems of Nuclear Powered Aircraft

It may be interesting to pose some difficult problems in addition to those mentioned above which confront the designer of a nuclear powered aircraft.

The shield will be the heaviest single object aboard the aircraft. Early published estimates of shield weight placed the minimum at 50 to 100 tons, without any provisions for removal of heat. From this it is evident that a large aircraft will be required to carry a weight of this magnitude even though the aircraft need carry little or no chemical fuel. To a first approximation one may balance off the weight of the shield against the weight of the fuel load which would be carried in the large modern aircraft, since the shield and the reactor which it contains essentially replace the fuel load. The fuel loads of modern aircraft range up to the neighborhood of 75 tons or more. If the early estimates of shield weight referred to above are anywhere near correct, it is evident that the weight of the shield plus the reactor is not grossly different than that of the fuel which can be carried in a large conventional aircraft. However, every effort must be made to keep down the weight of the shield and the reactor. One obvious way to do this is to make the reactor small so that the shielded volume is kept small. This in turn restricts the amount of cross sectional free flow area through which coolant may pass through the reactor and increases the pressure drop. Moreover, as the reactor diameter decreases it usually is found that more fissionable material is required. This is undesirable. There is therefore a balance to be struck between the benefit of small shield weights resulting from decreased reactor size on the one hand, and the disadvantages resulting therefrom in smaller free flow area for coolant flow and larger fissionable material investment required.

Balance and Structure

The existence of a large concentrated weight such as the shield and the reactor at one point in an aircraft, makes it necessary to redesign the structure of the aircraft to accommodate this weight. Although large aircraft are designed for very large gross weights this weight is usually distributed over the wing and throughout the fuselage. Concentrating the weight in the fuselage greatly increases wing bending

(continued on page 40)

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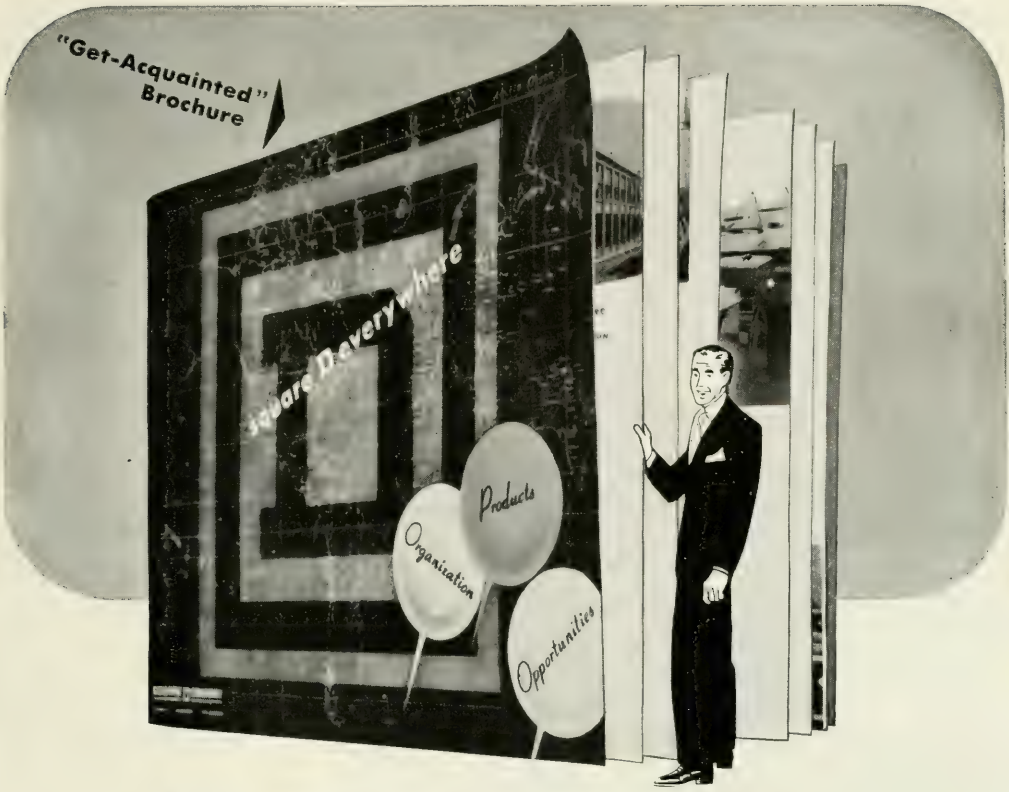

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ATOMIC AIRCRAFT . . .

continued from page 38

moments and necessitates structural redesign in many cases.

Large Landing Weight

The very fact that only a small amount of the fuel is consumed in flight means that the gross weight of a nuclear aircraft will be approximately the same on landing as on take-off. First, the landing gear must be made strong enough to take the higher gross landing weight. Second, the landing speed is increased and there may be a change in landing attitude which possibly could require changes in the landing gear, or in tail clearance angle requirements.

Heat Transfer

The very essence of a nuclear power plant is the transfer of heat from the reactor to the propulsion machinery. The requirements for small size and high power density placed upon the aircraft reactor push the heat transfer designer to the limit of his knowledge. He must avoid hot spots in the flow system, he must have good flow distribution and he must know exactly how the power is distributed in the reactor so that he can supply the right amount of coolant to each part of it. Solution of these problems requires a great deal of detailed analysis and experiment. For example, consider the cooling of a surface beneath which U-235 is located in a reactor. The rate of heat generation is independent of the local temperature, thus if the surface be deprived of its coolant it will at once rise in temperature until it melts or disintegrates. The reactor is like a heat exchanger to which heat is constantly supplied whether it is taken away or not; only by maintaining the flow of coolant can trouble be avoided.

Fissionable Material Investment

The desirability of keeping the quantity of fissionable material in the reactor small, has been mentioned previously. It is obvious that this is desirable. However, the chain reaction will go in the reactor only so long as there is present a certain minimum quantity of fissionable material called the critical mass. As soon as the reaction has consumed so much fissionable material that the mass drops very slightly below the critical mass, the chain reaction dies and cannot be started again without adding more fissionable material. Moreover, the products of fission remain in place in the fuel elements and eventually must be removed. This makes it necessary to remove the remaining fuel from the reactor, purify it and prepare it for reuse. The amount of uranium which may be tied up in the reprocessing activities may easily exceed that which is tied up in the reactor proper. Thus, the uranium investment is not simply the amount of uranium carried aboard the aircraft but also that which is on the ground in various stages of preparation for use. The question of recovery and reprocessing of the fissionable material is a matter for the chemist and chemical engineer, and is a whole new subject on which I shall not touch further here.

Radiation Damage

Inter-nuclear collision between neutrons and the nuclei of materials used as structures or as moderators in the reactor or between fission fragments and other nuclei result in dislocation of the nuclei with which collision occurs. While it is definitely known how great an effect these dislocations have it is known that the properties of the materials in which they have occurred undergo a change. Usually this change is in a detrimental direction. For example, a decrease in thermal conductivity may occur, thus making the heat removal problem ever harder. Or, other equally critical properties may deteriorate.

Some liquids or gases which might be proposed as reactor coolants are decomposed by radiation, and are hence not usable. Organic compounds are parti-

(continued on page 44)

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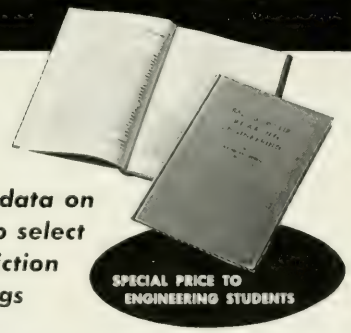

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TECHNOGRAPH

THE DU PONT DIGEST

Thurman W. Kaiser (*at right*), *B.S.Ch.E., Purdue '50, supervises tests of improved process for making neoprene intermediates.*

[FOURTH OF A SERIES]

Ch. E's at Du Pont

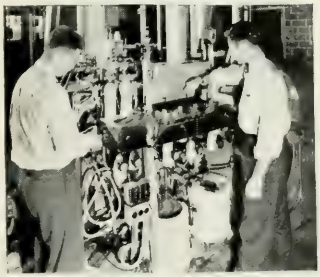
Plant development work is solid background for a future in chemical engineering

The work of production supervisors at Du Pont, as discussed here last month, is aimed at getting better results from existing processes and equipment.

In contrast, the job of plant development groups is to find ways to improve methods and products, and advise management when changes should be made for economic or technical reasons. Chemical engineers in this work are responsible for lowering process costs, adapting the product to new uses and improving product quality to obtain a larger share of the existing market.

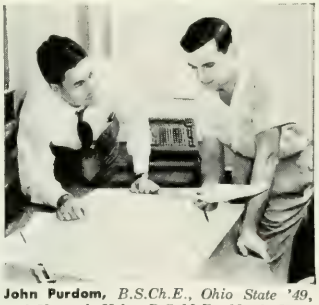
These duties provide an understanding of the fundamental aspects of the business, as well as a broad view of Company operations. The training and experience a man gains as a member of a plant development group—often a first assignment at Du Pont—is an excellent background for any field he may move into later.

Conducting a development study usually involves obtaining data from laboratory, semi-works and plant-scale experiments, estimating profits and investments, and consulting with sales, research and production personnel, also with auxiliary departments such as Engineering, Chemical and Purchasing, and with outside authorities.



H. E. Graham, Jr., *B.S.Ch.E., Georgia I. T. '48, and J. F. Carley, Ph.D.Ch.E., Cornell '51, study a plastic compounder-extractor-extruder for improvements in making plastics.*

Here are typical problems solved by plant development groups:



John Purdom, *B.S.Ch.E., Ohio State '49, and Kenneth Kehr, B.S.M.E., North Carolina State '50, discuss diagram of a process for improved recovery of a nylon intermediate.*

1. Prompted by obsolescence and wearing of equipment, experimental studies and economic comparisons were made on the entire process of isolating dyes. Methods in use called for crystallization, filter pressing and tray drying. It was found that a rotary vacuum filter with a continuous rotary steam tube dryer, air conveyor and a dust collection system reduced costs about $50,000 a year.

2. Production of sodium silicate was to be increased substantially, but the tank-type furnace at the heart of the process proved a bottleneck. The furnace design, including exit and entry ports, was improved, and its capacity enlarged at a small fraction of the cost of a new furnace.

Reid Earnhardt, *B.S.M.E., Cornell '44, M.S.M.E., Carnegie '48, and René M. LeClare, M.S.Ch.E., M. I. T. '51, check installation of improvements in plant equipment.*

With the rapid growth of technological improvements all over the world and increasing competition, plant development work assumes greater and greater status. The Ch. E. entering such a group at Du Pont finds a wealth of opportunity for his skill and ingenuity.

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SKIMMING . . .

continued from page 22

sheet of tracks and records information received from a truck operator on his master materials location sheet. This record is being continuously compiled by the dispatcher from truck operators' call-in reports so that he has the latest record of both material locations and quantities at these points.

Essentially, the regularly licensed installation is very similar to a taxi dispatching system.

no support for melting metals

In a nearly incredible experiment at Westinghouse recently, aluminum was melted by placing it between two horizontal coils of copper a few inches apart and applying energy at 10,000 cycles. As the switch was closed the aluminum actually floated into space between the two coils. It began to spin rapidly, glow red, soften, and turn to a liquid, assuming, as it did so, the shape of a spinning toy top. When the power was shut off the melt dropped to a crucible below where it instantly solidified.

This was the outcome of efforts to produce more nearly pure metals. When high-temperature metals are melted in a crucible, reactions occur with the refractory. But in the case where the metal is melted in air where volatile impurities are lost and other impurities are not picked up, greater purity is achieved. Alloys can also be produced while the metal is suspended. The induced currents automatically produce the necessary stirring.

Melting aluminum in air produces purer metals and alloys. (Courtesy of Westinghouse).

Although still limited in choice and quantity of metals, this process has been successfully employed in research for metals in lamps, electronic tubes, and other high-temperature applications, particularly where it is not necessary to greatly exceed the melting point of the metal.

crash trucks for air force

Details were recently released on the nature of several hundred crash and fire-fighting trucks to be built for the U.S. Air Force by Marmon-Herrington Co.

Known as Model 0-10, the new trucks are designed to operate efficiently in any temperature ranging from 65 degrees below zero to 165 degrees above, Fahrenheit. This extreme range necessitates, among other things, a completely automatic generating system to keep batteries charged at all times as well as an auxiliary heating system for engines.

The 0-10 is a high-speed vehicle used to reach crash scenes as quickly as possible. Featuring six-wheel drive, the new truck has maximum traction and can go through deep mud, sand and snow and up steep grades with amazing speed and ease.

Because of unique design, the Model 0-10 is able to close in on a crashed

(continued on page 46)

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PRATT & WHITNEY AIRCRAFT, leading aircraft engine designer and manufacturer has been a firm advocate of "creative engineering" for all of its 27 years in business. Operating as it does in a highly technical field, the company has never veered from the basic policy that engineering excellence is the key to success.

This has meant extraordinary emphasis on engineering, the formation of an engineering-minded administration, and the spending of millions of dollars of company funds to build the most complete research and development laboratories in the field.

Such an approach has enabled Pratt & Whitney to gain a top reputation for piston and jet engine development. Only recently the company became one of the few in the country to be awarded a U. S. Government contract for the development of a nuclear powered aircraft engine.

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THE STRIKING HEAD of this common kitchen match contains sulfur. It symbolizes the host of everyday items that would be affected by a severe sulfur shortage. Sulfur finds its way into almost every branch of American industry. It is important to the production of chemicals, fertilizers, petroleum products, and numberless other materials vital to the nation's defense program and to our normal industrial and economic development.

How the Petroleum Industry helped ease the Nation's Sulfur shortage

THERE IS A SAYING, "the best index of the level of the civilization of a country is its production of sulfuric acid." The U. S. would have had real cause to worry had the critical shortage of sulfur in the past 18 months gone unchecked.

However, since sulfur in the form of hydrogen sulfide occurs in natural and refinery gases, the petroleum industry took the impending shortage as its cue to step up its normally limited recovery of sulfur from these sources.

Accordingly, by mid-1952 recovery from petroleum and natural gas will have mounted to 700,000 long tons per year. This will provide substantial help in relieving the national shortage. Since this tonnage is considerably above the needs of the oil industry, it will ease the situation for many other industrial users.

Standard Oil has taken the lead in the midwest in this by-product sulfur recovery program. With facilities at Whiting and in the far west and south west, the company will produce nearly 10% of the sulfur obtained from petroleum sources.

Sulfur recovery and Standard Oil's part in it is just one example of how young men with training in chemistry and engineering may apply their skills and knowledge in our company—and gain deep satisfaction in the results of their work.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

ATOMIC AIRCRAFT . . .

continued from page 40

solely susceptible, and even outside the zone of most intense radiation in the reactor ordinary lubricants turn tarry or even solidify. Lubricated machinery hence may not be used in such locations. Electrical insulation, on prolonged exposure to radiation, breaks down and disintegrates or loses its effectiveness.

There is here a large field of investigation, particularly in the physics of solids, where much work must be done in order to elucidate the effects of radiation damage, as this phenomenon is called, on the materials which might be used in an aircraft reactor, or in radiation exposed locations in the shield.

Escape of Radioactivity

It is evidently necessary to confine substantially all the radioactivity of the reactor within it. This imposes on the designer of the reactor another restriction. It is occasionally suggested that a nuclear aircraft will create a hazard to population in its vicinity. Inasmuch as the aircraft itself will carry a crew which must be protected adequately, persons at a distance will not be affected in any way.

Materials

One of the most important problems in reactor technology today is the finding and development of materials adequate for use in reactors which are proposed for production of power in one form or another. The combined effects of high temperature, corrosion by various coolants, radiation damage, thermal stresses, and mechanical stresses can be extremely serious in some cases. The aircraft reactor presents these problems to an unusual and critical degree. For example, a difference of 100° F in permissable maximum reactor temperature can easily produce a 15 per cent difference in thrust output of the power plant. High temperature materials are therefore a prime necessity. A corrosion resistant coating on the reactor heat transfer surfaces a few thousandths inches thick may double the critical mass. A brazing alloy containing a few per cent boron (a strong neutron absorber) may put so much boron into the reactor that it cannot be made to go critical, and this particular alloy may therefore be entirely un-usable. An alloy high in nickel may have good corrosion and high temperature strength properties for use as reactor structure, but be so strong a neutron absorber as to be substituted by another alloy of lower nickel content and poorer corrosion and strength properties. The finding of materials adequate to withstand these conditions is a challenge worthy of the best metallurgist, ceramist or chemist.

Outlook

In many respects the propulsion of aircraft is an ideal use for nuclear energy. Here to a higher extent than in any other application the advantages of a highly concentrated source of heat can be used to good result. Although the goal of producing a nuclear powered aircraft is an admittedly ambitious one it is only such high performance, premium uses of energy which can today justify the consumption of as rare a resource as uranium-235 or plutonium-239. Moreover, it is inescapable that a development of this type has great military significance.

In recent months the government has announced that the nuclear aircraft program is entering a new phase. In this new phase the Aircraft Gas Turbine Department of the General Electric Company has been given the responsibility for the propulsion system and the Consolidated Vultee Aircraft Corporation is to supply an airframe.

My belief is that our efforts to fly an aircraft on nuclear power will be successful. The difficulty of the task and the value of the result combine to form a challenge which is in my opinion unmatched.

And then there was the deaf mute that fell into the well and broke three fingers screaming for help.

NEW PLANT MAKING AGRICULTURAL AMMONIA USES FRICK REFRIGERATION

The Mississippi Chemical Corp. at Yazoo City uses three Frick compressors to hold 2,000 tons of liquid ammonia in the spherical tanks (at upper right) by reducing the pressure and temperature.

This eight-million-dollar plant, built by 10,000 stock-holding farmers, produces both liquid ammonia and solid ammonium nitrate for use as fertilizer.

Installation by Munford Engineering Co., Frick Distributors at Jackson.

Three Frick Compressors in Service at the Mississippi Chemical Corp.

The Frick Graduate Training Course in Refrigeration and Air Conditioning operated over 30 years, offers a career in a growing industry.

DEPENDABLE REFRIGERATION SINCE 1853
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An extra tough, tinned steel tape line ½" wide, designed especially for mine work. Clear, sharp graduations and figures deeply stamped into nickel silver sleeves—securely soldered to steel line. Strong metal reel, nickel plated. Long folding winding handle, ample size hardwood carrying handle. Reels of tapes up to and including 150 feet are 4-arm pattern, over 150 feet, 5-arm as illustrated. Leather thongs supplied. Available in all desired markings.

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FROM YOUR HARDWARE OR TOOL STORE
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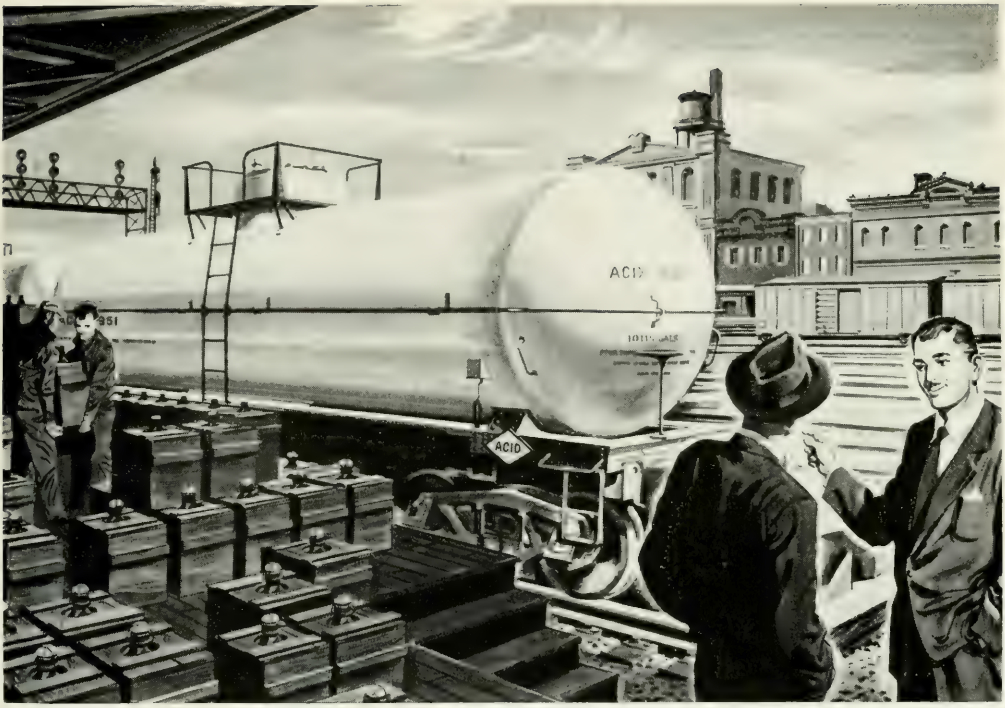

This car replaced 615 "Bottles"

ANOTHER ALCOA DEVELOPMENT STORY:

In 1927, a chemical manufacturer asked us, "Why must some chemicals be handled in small drums or carboys . . . can't tank cars be built of aluminum?"

From our years of research, we knew that we had alloys compatible with many chemicals—and experience in fabrication methods dictated welding. The Field was inviting, and we decided to design and pay for the first aluminum tank car ourselves.

Our engineers designed an 8,000-gallon tank, to be welded together from 16 large aluminum plates. Working with a leading tank car builder, lessons which we had learned in other Alcoa developments enabled us to materially assist in the alloys selected, welding techniques and structural fabrication methods employed. One year later, in 1928, the car was completed. It was then tested in 20,000 miles of road service, while hauling glacial acetic acid—a typically tricky cargo. It weathered 3,500 recorded shocks—900 severe ones. That aluminum car is still in service!

Together with tank car builders, we have developed improved riveted and welded car designs, which are now "standard." Today there are over 1,300 aluminum tank cars carrying the fussy compounds that formerly traveled only in small containers.

This is typical of the development jobs we do at Alcoa. Others are under way now and more are waiting for mechanical, metallurgical, electrical, chemical and industrial engineers having the imagineering skill to tackle them. Perhaps you may be one of those men. ALUMINUM COMPANY OF AMERICA, 1825 Gulf Building, Pittsburgh 19, Pa.

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A business built on co-operation

ALCOA

ALUMINUM COMPANY OF AMERICA

SKIMMING . . .

(continued from page 42)

plane above the fire away from the crew compartment and permit rescue even before the fire is totally out. This is accomplished by a cab-controlled air-foam turret nozzles in conjunction with powerful ground sweep sprays. The delivery pressure for the major extinguishing agents is derived from a pump driven by a separate engine which is carried amidships.

an atomic yardstick

Atomic radiation may someday be harnessed as the most accurate measuring devices, according to I. F. Kinnard, manager of engineering for GE and leading authority on measurements.

Speaking on future instrument design and engineering trends, he said that "the potentialities of atomic radiation in the field of measurements are boundless." As an example of how radiation could be used as a "measuring stick," he explained, "would be to direct the rays into a container of liquid. On striking the liquid, the rays would be so affected that when measured they would indicate the exact amount in the container."

However, before such steps are taken, new instruments to measure radiation itself must be developed. These instruments would have to meet requirements much higher than present-day needs if the atomic power is to be used to generate electricity, or to run ships and aircraft.

"Great strides will be taken in the development of new instruments," he predicted, "to assume the most efficient and reliable operation of atomic power plants. This development work must be given important priority, so that new applications of atomic energy are not delayed."

He also warned that research in this field would involve nuclear physics, "a little-tapped field in the measurements industry."

new dentifrice uses glycerine

According to the makers of a new dental preparation, glycerine has solved the dentist's problem of pastes which splash and spatter when used for cleaning teeth with mechanical equipment. The product is made solely for professional use, and it is one of the first of such compounds to be made available in ammoniated form. The doctors who developed it explain that glycerine was the only binder they found which provided all the qualities they desired, including the non-spattering property.

Chief ingredients are dibasic ammoniated phosphate, carbamide, a synthetic detergent, and pumice, which are held together by glycerine to form a smooth past which does not separate or dry out. Glycerine's plasticizing effect and the good consistency it imparts allow the paste to be used without water, which accounts for the absence of spattering when it is applied by mechanical means. Glycerine is also said to help preserve the high ammonia content during shelf life.

atom-smasher x-ray for cancer treatment

An atom-smasher that develops the most powerful X-ray beam ever generated specifically for the treatment of cancer is now being assembled at the University of California School of Medicine, San Francisco.

The machine is a synchrotron that produces an X-ray beam of 70,000,000 volts. With it, University of California scientists will do some pioneering research on the possibility that ultra-high energy X-rays have some advantages in treating deep-seated cancer.

The synchrotron, purchased with funds from the Atomic Energy Commission, has just arrived in San Francisco. It was designed and constructed at Schenectady, N. Y., by GE scientists and engineers.

The new cancer-fighting weapon is being reassembled in a two story building constructed especially to house it and its associated laboratory. Total cost of the machine and the building, all financed by AEC funds, is about half a million dollars.

Dr. Robert S. Stone, professor of radiology and one of the pioneers in the application of nuclear physics in medicine, is the director of the project.

Dr. Gail Adams, physicist in charge of the operation of the machine, came to the School of Medicine from the University of Illinois, where he played an important role in the development of the 20,000,000 electron volt betatron, presently the most powerful X-ray weapon used in cancer treatment.

Work with the 20,000,000 volt betatron indicates it is possible to put a higher dose of radiation in deep-seated tumors than with lower voltage machines. At 70,000,000 volts this effect may be even more pronounced. Due to the flexibility of the machine it can be adjusted between 20,000,000 and 70,000,000 volts.

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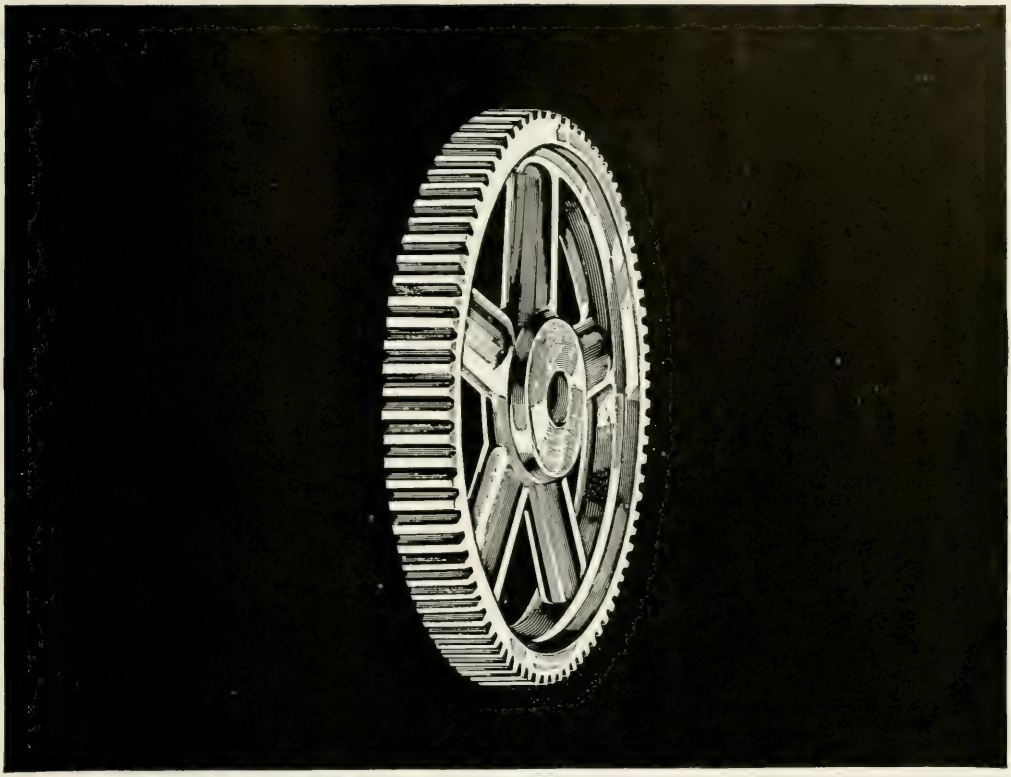
TENSION CONTROL
AND LEATHER
make a good team
FLAT LEATHER BELT
TENSION CONTROLLING MOTOR BASE
In the fielder's glove, a hand controls the tension that makes the leather take hold. In the Uni-Pull drive, a tension-controlling motor base and a modern leather belt team up in practically the same way. The base maintains belt tension . . . keeping leather's high pulley grip at work, effectively transmitting power.
American LEATHER BELTING Association
AL-51

Army Doctor: "Now look here, my good man. You know very well you wouldn't come to me in civilian life with a thing like this."

Recruit: "Of course I wouldn't. I'd send for you!"



ANCESTRY UNKNOWN . . .

No one knows who first thought of gears as a means of transmitting power or motion . . . but without them modern civilization could not function.

There would be no clocks, cars or calculators . . . industry would revert to hand production . . . transportation would go back to the horse and buggy . . . household chores would multiply . . . office managers would be seeking mathematical geniuses.

FUTURE UNLIMITED . . .

A gear never works alone. Only when properly meshed can it function efficiently. So, in industry, minds must mesh if progress is to result. Here, in America, engineers, inventors, machinists, toolmakers are geared for great advancement. And their point of contact is America's all-seeing, all-hearing and reporting Inter-Communications System.

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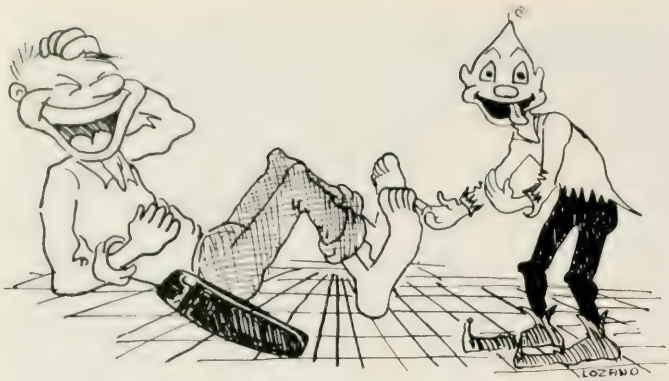


TECHNOCRACKS

edited by Pete Cattapan, gen.e. '53

Child specialist to mother of small boy: "You'll have to handle this child carefully. Remember, you're dealing with a sensitive, high-strung little stinker."

* * *

Report of tardiness to 8:00 classes: A body in the sack tends to remain in the sack. The cohesive force between the body and the sack varies as the square of the time the body is in contact with the sack.

* * *

Math Prof.: "Give me an example of an imaginary spheroid."

Engineer: "A rooster's egg."

* * *

A local policeman stopped his squad car and hailed an inebriated gentleman who was making his dubious way down the street.

"Hey you," he shouted, "where are you going in that condition?"

"Gonna work," mumbled the drunk.

"Oh yeah," growled the officer, "what kind of work can you do in the shape you're in?"

"Mmm."

"Minin what?" persisted the cop.

"Minin' my own damn business," snapped the drunk, "and why don't you do the same?"

* * *

Engineering Student: "Do you serve crabs here?"

Bidwell's Waitress: "We serve anyone."

* * *

Lo and behold, engineering has invaded South Campus. "Fire," the play which won first prize in the Contemporary Arts Festival, was written by Arthur Gregor, an electrical engineer living in New York City. The play will be given during the first part of April.

An elderly woman visiting the zoo wanted to ride a camel. The keeper hoisted her up, but was unable to make the camel move.

At last the lady dismounted and started to pet it. Suddenly it went running off as fast as it could. The keeper turned to the old lady.

"Madam," he said, "what did you do to him?"

"I tickled him," she replied.

"Well," said the keeper, "you'd better tickle me. I've got to catch him."

* * *

Suggested slogan for parents with kids in college: "The Dough must go on."

* * *

It's possible some of those gangsters meant, "I refuse to answer on the grounds it may incinerate me."

* * *

Clerk: "Did you kill any moths with those moth balls I sold you the other day?"

Customer: "No, tried for five hours but I couldn't hit one."

* * *

Newcomer to Champaign: "How does the land lie around here?"

Old-time Resident: "It isn't the land that lies. It's the real estate agents."

* * *

"Is there anyone present who wishes the prayers of the congregation for a relative or friend?" asked the minister of the little New England church.

"I do," said an angular lady arising from the rear pew. "I want the congregation to pray for my husband."

"Why, sister Abigail," replied the minister. "You have no husband as yet."

"Yes, that's why I want you all to pitch in and pray for one for me."

The excited voice of a young Smith girl came over the phone: "Two boys are trying to break into my room through the window!"

"Listen, lady, this isn't police headquarters; this is the fire department."

"I know," she answered, "but my room is on the second floor and they need a ladder."

* * *

Recently the following testimony was received by a patent medicine concern:

"For nine years I was totally deaf, and after using your ear salve for only ten days I heard from my brother in South Dakota."

* * *

She: "Time separates the best of friends."

He: "It sure does. Twenty years ago we were both seventeen. Now you're twenty-four and I'm thirty-seven."

* * *

"Is Jim a tightwad?"

"Well, every time he takes a nickel out of his pocket, the Indian blinks at the light."

* * *

Boy: "Shine your shoes, mister?"

Instructor: "No."

Boy: "I'll shine them so you can see your face in them."

Instructor: "No, I told you!"

Boy: "O. K.—coward!"

* * *

LAS Student: "Have you read the professor's new book?"

E.E. Student: "Yes."

LAS Student: "What do you think of it?"

E.E. Student: "Well, to be frank, I think the covers are too far apart."

* * *

"Hello."

"Hello."

"That you, Jake?"

"Yep, this is Jake."

"It doesn't sound like Jake."

"Well, this is Jake speaking all right."

"Are you sure this is Jake?"

"Sure, this is Jake."

"Well, listen, Jake, this is Henry. Lend me fifty bucks."

"All right, I'll tell him when he comes in."

* * *

There is only one engineer who ever became rich. He recently died in Colorado and left a fortune of $50,000 which he amassed through unceasing toil, superhuman perseverance, remarkable ingenuity, and the death of an uncle who left him $49,999.

* * *

It was my intention to write a column of jokes. I have written a column. Now read the articles. They're probably funnier.

illinois technograph

.25

may, 1952

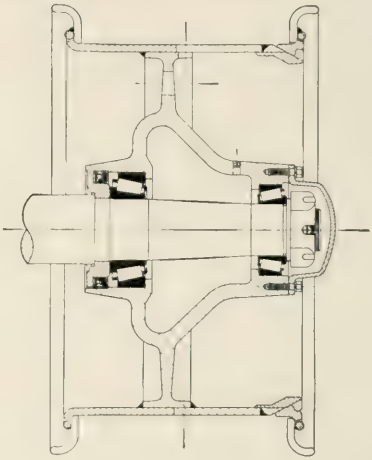
Another page for **YOUR BEARING NOTEBOOK**

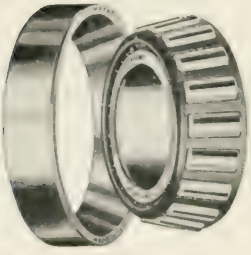
How to help a scraper do its level best

Bearing applications on large-capacity scraper wheels pose two problems to design engineers. One is the heavy loads. The other is wear. Engineers solve both problems at once by mounting scraper wheels on Timken® tapered roller bearings. Line contact between rollers and races of Timken bearings provides extra load-carrying capacity. The true rolling motion and incredibly smooth surface finish of Timken bearings practically eliminate friction and wear within the bearing.

Mounting scraper wheels on TIMKEN® bearings

This is a standard wheel application showing indirect mounting of Timken bearings. The bearings are adjusted by means of a nut. Cups are mounted in the counterbored hubs. The use of Timken bearings in this application keeps the shaft concentric with the housing, thus the seals are more effective in keeping dirt out, lubricant in.





TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

How you can learn more about bearings

Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For a copy of the 270-page General Information Manual on Timken bearings, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ◎ AND THRUST —◎— LOADS OR ANY COMBINATION ✳

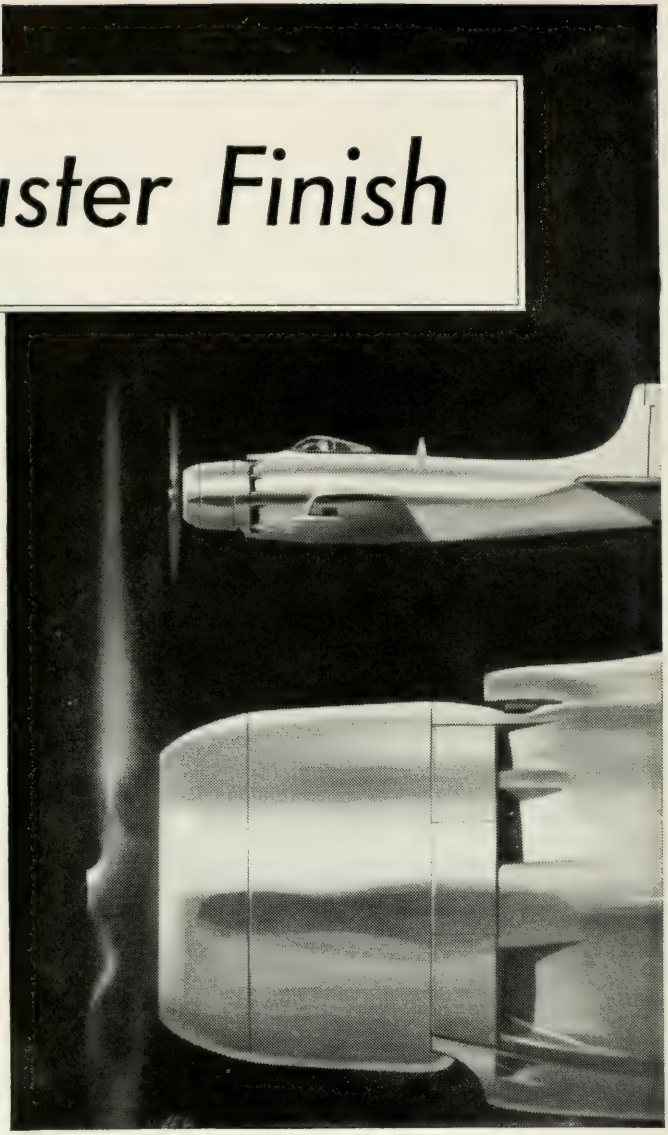
Whose fault?

Near the end of April every year, Ma-Wan-Da and Sachem select their new members. The ILLIO prints its pages of campus leaders. Yet, few, if any, of those honored are engineers. This year two engineers were campus leaders, and they held posts which are listed every year. Why are there so few engineers honored? Who is at fault?

Surely, you say, the people south of Green Street are responsible. Are they not the ones who control the selection? Certainly the president of the Engineering Council is a campus leader. Is he not the student head of one of the largest colleges in the University? I might stick out my neck and say, "Why not the editor and business manager of the TECHNOGRAPH?" The TECHNOGRAPH reaches all the high schools in the state. Neither the DAILY ILLINI nor the ILLIO helps to influence the high school student in a similar manner.

But all the blame can not be placed on the door-steps of our south campus neighbors. You, ENGINEERS, must carry your share of blame. More of you must become active, not only in engineering activities, but elsewhere. I know that you have come to Illinois to learn to be an engineer, but an engineer must be more than a calculating machine. An engineer must be human. More and more, industry is placing engineers in executive positions. In such a job, the engineer must be able to work with persons who are not engineers. You can learn that only by working with those who are not engineers. I do not advocate your quitting engineering activities. It is hard enough to get you to work on them now. I do advocate your getting to work on activities. Why is the engineer so often pictured as a grind who does nothing but eat and study (no sleep)? Because too often this is true of the engineering student. It need not be this way. Cut out your bull session once a week and join an activity. Only by overcoming the rest of the University by sheer numbers of students in activities can we ever be recognized by south campus. Do you want more engineers to be recognized for what they are worth? Then be worth something more than a machine. Get to work.—T.C.T.

No Faster Finish



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. . . finishes for aircraft and other military needs which can be applied fast, dry fast without baking, and stand up under severe service conditions.

SOLUTION . . .

. . . hot-spray lacquers now made by many companies from Hercules® nitrocellulose. These new lacquers, thinned by heat rather than solvents, permit more actual lacquer to pass through the spray gun. Now, one hot coat frequently does the job where two coats had been used.

COLLEGE MEN . . .

This is but one example of the far-reaching chemical developments in which you could participate at Hercules—in research, production, sales, or staff operations. It suggests the ways Hercules' products serve an ever-broadening range of industries and end-uses.

Hercules' business is solving problems by chemistry for industry . . .

. . . insecticides, adhesives, soaps, detergents, plastics, paint, varnish, lacquer, textiles, paper, rubber, to name a few, use Hercules® synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products, and other chemical processing materials. Hercules® explosives serve mining, quarrying, construction, seismograph projects everywhere.

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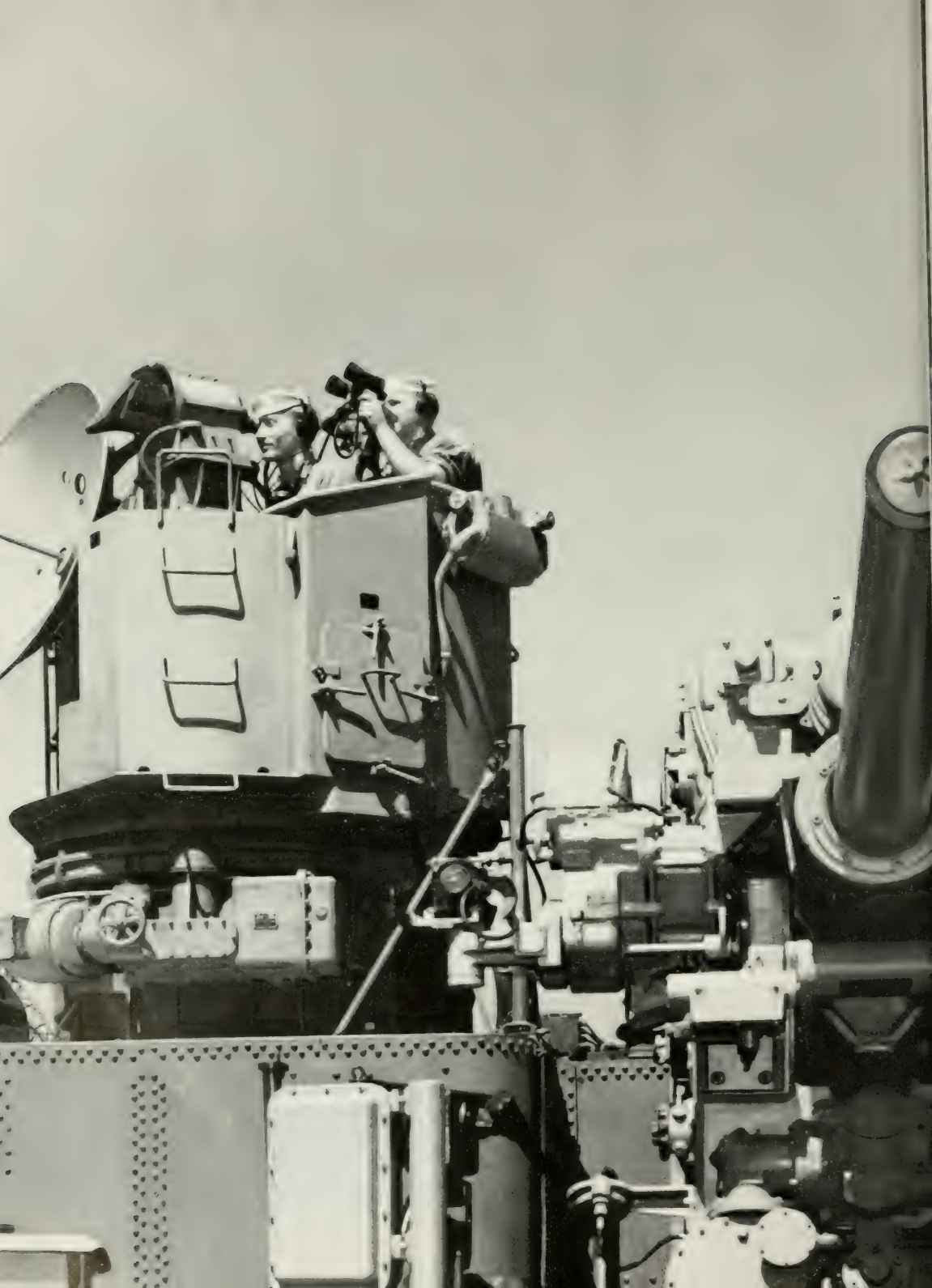
our cover

An electrical engineer checks a 6,000-kva multi-circuit unit substation. Power distribution is a very important phase of the electrical engineer's work. Our featured engineer this issue, the EE has made life more comfortable for millions of Americans. It would be difficult to imagine life in these United States without the benefit of modern planned electrical living. We salute you, EE: your ingenuity and foresight have enabled engineered progress to exceed all bounds. (Cut courtesy of Allis-Chalmers ELECTRICAL REVIEW)

our frontispiece

Navy men manning an electrically controlled gun-director. On the sea as well as on land, the electrical engineer has applied his knowledge toward the ends of national defense. In electronics and communications the engineer has bridged the gap of space, darkness and weather. In his efforts directed toward improving the instruments of defense, the EE has discovered applications adapted to our everyday living thus widening the scope of our material comforts. (Cut courtesy General Electric Company)



industry appraises . . .

Merits of Engineering Graduates

by J. L. Michaelson, General Electric Company

What are the characteristics that General Electric looks for in the engineering graduate? This question is often asked, and it is one to which there are, perhaps, many sincere but different answers given by General Electric men.

A sales engineer in one of our district offices might be inclined to stress personality characteristics; a design engineer from the Turbine Divisions might emphasize technical analytical ability; a laboratory man would be sure to want keen observation and creative ability. All of these men would no doubt agree that the young engineer graduate should possess adequate training in fundamentals, but, upon further questioning, they might have difficulty agreeing on what the "fundamentals" are.

If General Electric men do not always seem to agree, then it is not surprising that other companies may appear to have different standards. A small electric motor manufacturer might want the new engineering graduate entering his employ to be a pretty good expert on the design of small electric motors. He might hope that a large part of the engineering curriculum dealt with small electric motor design, perhaps, to the complete exclusion of such subjects as advanced thermodynamics and electronic circuits. Naturally, such an engineering curriculum would not produce the "expert" needed by a turbine manufacturer or by a radio manufacturing business. Since there is no way to determine in advance what kind of engineering job the graduate will find himself in, it is necessary to have an engineering curriculum which will give the engineering student as broad a training as possible.

The engineering curriculum has been given a tremendous amount of study and thought by the country's best qualified men. Development of this curriculum never will be complete, of course, but today's engineering curriculum seems to pretty well fill today's needs.

I believe that the engineering student should put forth his very best efforts on all the subjects in this curriculum. There is a good reason for each subject. The student may not like some of them, but he should realize that these subjects are not put in to punish him, but are there for his development.

In applying his best efforts to all subjects, a student will whet his appetite for new knowledge; sharpen his wits and powers of observation; develop logical thinking; increase his store of knowledge, and develop a strong desire to accomplish something worth while. At the same time, he will learn how to cooperate with his fellow students and faculty alike; he will learn the importance of teamwork and develop an appreciation for the other fellow's point of view. He will learn the importance of serving his profession faithfully and discharging his obligations of citizenship with unselfishness.

What, specifically, are the characteristics the General Electric company is looking for in the engineering graduate? We are interested in the kind of job he has done at this business of going to college. The best way to judge a race horse, they say, is to determine how he has run in the past.

We are interested in whether the student has met his obligations, taken advantage of his opportunities and developed his concepts of morals and ethical conduct. Has he learned to think logically? Does he appreciate the other fellow's point of view? Does he have a strong urge to accomplish worth-while things? Is he alert? Is he of sound character? Does he have a desire to expand his knowledge? Is he creative? Is he willing to work hard? Is he a little bit humble toward the world? Is he versatile enough to be adaptable in any situation? These are the kinds of questions which run through a General Electric recruiter's mind, and as might be expected, different recruiters will give these characteristics slightly different weight, but, generally they will arrive at similar conclusions on a particular individual.

I have said very little about looking for an "expert" in any particular line. Our activities are so broad and diversified that we need all kinds of "experts," but we think the best way to get them is to train them ourselves. Therefore, we look to the engineering college for the basic engineering training. We have little interest in specialization at this stage of the engineer's development.

The young technical graduate enters the General Electric company through one of several technical training programs designed to bridge the gap between college and industry. It is through these programs that he learns about the company's many and diversified operations, and, thus, the details of the many opportunities available to him. He has an excellent opportunity to develop his ability in the field of his particular interest.

For those who have the desire and aptitude for sales engineering, we have a program designed to give them the kind of practical experience they will need, together with appropriate classroom work.

Similar arrangements are made for those interested and qualified in manufacturing engineering.

A creative engineering program is available to those with aptitude for creative work in engineering.

Our Advanced Engineering Program is nationally known for the quality of its graduates. The men who qualify for this program are given a well-rounded training in fundamentals, and they specialize in one of the several fields.

In addition to these formalized programs, there are many other educational opportunities available to the young engineer in General Electric. He is encouraged to continue his engineering education through these company programs.

Our engineers must do more than keep abreast of engineering knowledge; they must lead in their respective fields.

This $1,300,000 structure, dedicated in 1949, houses one of the finest and best-equipped electrical engineering schools in the country.

the Technograph features the . . .

Although the electrical engineering school is one of the youngest in the engineering college, it has grown more since its formation than perhaps any other department in the college.

As in most universities, the E.E. school here at Illinois had its beginnings as a division of the physics department. It was first made a separate school in 1895, when the University was under the administration of President Draper. It remained a separate school for just one year, and then was recombined with the physics department until 1898 when the two departments were again separated, this time for good.

At this time, the department shared the Mechanical and Electrical Engineering building, now called the E.E. Research Lab with the M.E. department. The University power plant was also located in that building. When the power plant was moved in 1911 to the Mathews avenue building, the resulting space was devoted to lecture rooms for the E.E. department.

In 1925, due to the great increase in enrollment in the new school, a complete dynamo lab was equipped, and in 1929, the T.&A.M. department moved to Talbot lab. This left the old T.&A.M. building for the use of the electricals. This building, which is now called the E.E. Annex, is located just across the Boneyard from the E.E. Research lab. The two buildings were connected with a hallway which bridges the Boneyard.

At this time, the combined E.E. buildings housed a dynamo lab, a radio lab, and a communications lab, plus lecture rooms and space for individual research. The lecture room seated 300 and was considered quite adequate.

Around 1928, the Bell Telephone system donated much equipment to the University, including an artificial line which simulated 200 *mi.* of open wire telephone line, a variable frequency oscillator, and several other items. Western Electric gave the department about 150 *ft.* of lead sheathed telephone cable containing 600 pairs of wires. It was installed between the E.E. Research lab and the E.E. Annex. Through a system of connections, the 600 pairs of wires could be connected in series, giving the equivalent of 12 *mi.* of twisted wire line.

The equipment owned by the department at this time was largely power equipment, but the communications lab contained several switchboards, the necessary cable, coils, and instruments for comprehensive study of telephone equipment and circuits.

The electronics and radio study division of the E.E. school was started in 1933-34. Much of the equipment was designed and built by students. The radio lab had been built before this, back in 1921. The University was granted a license by the FCC to broadcast on 360 meters, that is, a broadcast band frequency of 836 kilocycles. This station was the forerunner of WILL.

In 1933-34, another FCC license was given to W9YH, a short wave station broadcasting on 80 meters. This station is now operated by Synton, the amateur radio operators' organization on campus. It is interesting to note that, at this time, the department owned a 250-watt television transmitter. This was of the old scanning disk type and never went on the air. Demonstrations of TV transmission were given, however, at the E.E. shows, which were similar to engineering open house.

During these years, the illumination men were not standing still, either. In 1938, Professor J. O. Kraehenbuehl, present head of the illumination option, supervised the building of an icosohedron photometer, one of the few in the world. This was a twenty-sided room, ten feet in diameter, and was used for making light measurements.

The E.E. department continued to expand until it was decided that there just was not enough space to accommodate the large number of men desirous of entering this rapidly growing field. In February of 1947, construction beban on the present E.E. building. The structure was built at a cost of $1,300,000 and an additional $300,000 was spent for equipment at that time. The building was dedicated in 1949. Since that time, many additional appropriations have been granted for equipment, until today, the electrical engineering school at the University of Illinois is one of the finest and best equipped in the country.

The new building's 80,000 square feet of floor area is divided into three floors and a penthouse. Most of the space is taken up by laboratories and offices. There are just 13 classrooms in the E.E. building. Most of these are located on the third floor along with the electronics, communications, radio, and ultra high frequency laboratories. The new network analyzer is also located on the second floor along with the network analyzer conference room. Laboratories and shops for the servicing of equipment, and instrument rooms are found on the second floor.

Electrical Engineering Department

by Don Sweet, e.e. '53

The first floor houses about half of the office space along with circuits and measurements laboratory. The E.E. lounge is in the northeast corner of this floor. Two lecture rooms with upholstered theatre type seats are located on this floor and are used for hour exams, club meetings, and seminars.

Downstairs, the largest area is used for the power lab. The power lab has a large plate glass window which allows visitors to see the entire lab. The lab has its own instrument room. Immediately in back of the power lab, the E.E. building shop is located. This is a complete machine shop used by building and machinery maintenance men.

The building has its own power substation, and a system of panel boards which permits the delivery of various AC and DC voltages to any lab in the building. For safety, the power lab has emergency push buttons located on every column. These buttons kill all the power in the lab with the exception of the lighting circuit.

The power lab here at the University is one of the largest labs of its kinds in any educational institution. It has been the policy of the department to furnish enough equipment in all of its labs so that an entire lab section may work on the same experiment at the same time. This means several sets of each kind of equipment. The department feels, however, that the expense of this duplication of equipment is warranted by the savings in instruction time. The lab instructors spend less time in explaining the experiments and have more time for giving individual help.

While less impressive perhaps, the electronics and communications labs are no less completely equipped. In the communications lab, transmission of intelligence along wires is studied. The lab contains several artificial lines simulating several miles of open-wire and twisted pair lines.

The radio lab contains all the necessary equipment for a comprehensive study of present-day radio circuits. Modern AM and FM receivers are laid out on large "breadboard" type layouts, permitting graphic demonstration of the functions of the various elements making up a modern radio receiver.

The penthouse of the E.E. building, added to the building after its completion, houses the antenna laboratory. Here measurements of radio wave field strength are made, and various antenna designs are studied.

The latest addition to the vast and expensive equipment in the E.E. building is the network analyzer. This apparatus, which fills an entire room, was begun in 1950 and was completed in April this year. The cost of the analyzer, about $50,000, was paid chiefly by three power companies.

The analyzer is a machine which is capable of solving 400 simultaneous equations. These equations must be set up in the form of electrical networks before they can be put into the machine. The answers can be read from meters at the control desks. Problems are usually worked on a per-unit basis, so the readings of the meters must be multiplied by some factor to give the desired answer.

The big use of the analyzer is in

(continued on page 32)

Left to right, Glenn M. Cate, Professor Max A. Faucett, and Professor Paul A. Egbert operate the "electric network analyzer" which is used to reproduce power networks and as an electric calculator.

. . . where the civil engineers learn surveying

by Warren Brandt, c.e. '54

A tourist from the Prairie State driving along one of Minnesota's scenic, lake-lined state roads might be somewhat surprised to see the above sign . . . a symbol of civilization in a region of wilderness. And his amazement would increase as he entered the grounds of Camp Rabideau, the University of Illinois Civil Engineers Surveying Camp.

The visitor would find a number of green painted buildings, kept in good repair, the evidence of a former CCC camp in the heart of the Chippewa National forest. Further examination would disclose barracks-type structures used for student housing. Camp offices and storerooms are in other buildings of a similar description. The entire camp has its own water supply and electricity is flickered in by the REA.

The civils have been coming to Camp Rabideau since 1946, when the University established this field laboratory for surveying and mapping instruction. Suitable sites were extremely difficult to find and this camp situated six miles south of Blackduck, a two-tavern town 35 miles northeast of Bemidji, the home of Paul Bunyan, was the answer to the search.

The student at Camp Rabideau occupies his daylight hours with field instruction in the course designated as C.E. 102. He becomes familiar with the tape, transit, level and plane table, the latter being sort of a drawing board mounted on a tripod.

The work with the tape takes the student over a good deal of the surrounding terrain, and sometimes when the pull on the tape exceeds the breaking point of the material, well, "Mac," Camp Rabideau's official repairman, has work to do (including the preparation of a bill)! Judicious handling of the tape can forego this possibility, however.

The transit and the level of course are the most coveted prizes and the student is probably more eager to learn their operations than to perform any other feat. Since he has probably seen the instruments in use he has a natural curiosity concerning their function and the average student easily becomes proficient in their handling.

Associated with the work with the transit are observations taken on Polaris, a star located somewhere in the heavens. This rather evasive orb holds a special charm for the engineer and it would seem that he would rather be viewing it than doing anything else. Naturally the observations on Polaris must be carried on at night as everyone knows the only way you can see this star in the daytime is from the bottom of a deep, dark, vertical mine shaft. Such an item is not available at the camp at present.

The student is introduced to mapping by making a map, a rather efficient way to say the least. He has the pleasure of working on Montgomery's field, a local character who blew his neighbor's head off (neither of them are around anymore), or maybe over by Jack Smith's place. Jack's the man who rents boats on Lake Rabideau. Or perhaps he would like to map those extensive wooded areas southwest of the camp. Beautiful country and the wildlife in there, why it makes you think you're with the Natural History Survey.

Mentioning the lakes seems a good time to tell about them. They are three in number, Rabideau, Carle and Benjamin. The latter has a very good reputation for swimming and fishing; besides it's only 300 feet away from the back door of Barracks 12.

The lakes occupy a short period of the student's time during which he sounds one of them, plotting his soundings on a chart he has drawn. When it's on land it's a map, when it's on water it's a chart. Confusing? He will find that Benjamin will sound around 150 feet. Pretty deep, eh?

But lest the visitor think that all the civils do at Rabideau is work, let's mention the other attractions. In the evening there is the baseball game. Now there is quite a rivalry between the different barracks, and the competition is pretty keen for the championship. Near the close of camp the two top teams are locked in conflict and the winner is cheered by all. At this point I would be derelict in my loyalty to the civils from Barracks 12 if I failed to note that they were 1951 champs.

Of course with the lakes so close, every student takes advantage of the opportunity to get in a few strokes. The water is cold but after a hot day in the field, it's pretty refreshing. Occasionally someone taking a measurement too near the shore will take an unannounced dip, but again a word to the wise is sufficient.

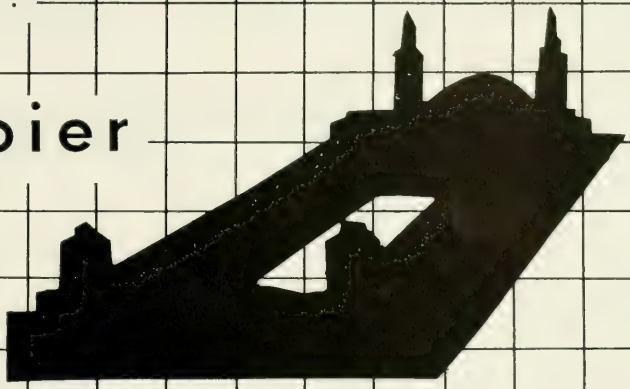
Movies have given considerable entertainment for the students and they are offered several times a week in a theatre seating 100. Also in this building is a library which attracts the bibliophile. For obvious reasons technical books are *not* available.

The features for which the student is especially attracted to Camp Rabideau are its wonderful climate and its unique scenery. Of course Minnesota has many such areas as that around the

(Continued on page 34)

— *the university of illinois at . . .*

navy pier



by Melvin H. Beckman, arch.e. '55

PIER IN THE PUDDLE

On March twentieth and twenty-seventh, the physics club held two meetings designed to familiarize its members with the development, operation, and uses of one of the more recent additions to the Chicago Medical Branch of the University of Illinois, its betatron. These two meetings consisted of a lecture on the machine by a member of the faculty, followed by a field trip to the Medical Center to see it in operation.

The idea for the betatron was originated in Germany about 25 years ago, but was not put into practical use until 1941 at the University of Illinois in Urbana. Essentially it consists of a high voltage transformer whose secondary coil has been replaced by an evacuated doughnut shaped tube made out of a ceramic material. The electrons are introduced into this tube by means of a heated filament. The magnetic field set up by the primary coil then accelerates them in a circular orbit to a speed they would attain when falling through a potential of twenty million volts.

In order to utilize these electrons it is necessary to remove them from the tube. This is accomplished by passing them through a laminated iron magnetic shield which will temporarily interrupt the magnetic flux set up by the primary coil. This will allow the electrons to escape their circular orbit and pass through a thin metal window in the ceramic tube. X-rays which contain more energy than the ordinary kind are produced by placing a metal target in the electron orbit.

The X-rays are used in the treatment of cancer. The electron beam can be used in the cancer treatment or in nuclear research.

The tour through the betatron laboratory consisted of the inspection of several different rooms which contain equipment used in connection with the betatron. There is a well equipped machine and electronic shop where auxiliary apparatus can be made when the need arises. Next to this is a storage room where instruments that are not in use are kept.

The area containing the betatron is divided into two parts separated by a lead lined wall. One side contains all the various electronic apparatus which is used in the operation of the machine and on the other side is the machine itself. It is a huge piece of equipment weighing about eight tons and is in the shape of a six-foot cube. When in operation the betatron gives off a high pitched whine which is caused by the magnetic flux being set up in the primary coil. Directly behind this room there are the power transformers. Here line voltage of a 220 volt potential is stepped up to about a 16,000 volt potential and its 60 cycle frequency is changed to 180 cycles.

During our stay at the laboratory we were very fortunate in having one of the members of the staff, Mr. Walter Henderson, as our guide. His explanations of the various pieces of equipment helped make our visit a most pleasant and informative one.

AIEE

On Tuesday, April 29, the American Institute of Electrical Engineers will go on a field trip to the Commonwealth Edison Company to inspect their network analyzer. This is a device which is used to determine anything wrong within the network.

The American Institute of Electrical Engineers will hold its annual election of officers during its May 13 meeting.

ENGINEERING COUNCIL

After a great deal of discussion, it was finally decided to hold a smoker on May 27 in the third floor lounge, from 2 o'clock until 5 o'clock in the afternoon. It is expected that there will be an abundance of FREE cigarettes and cookies for consumption by fortunate Pierites attending.

PERSHING RIFLES

The National Society of Pershing Rifles, Co. F, 3rd Regiment of the University of Illinois has started its new semester.

The elections which are held at the end of every semester resulted in James Trail being elected to the office of Captain Pershing Rifles. Other men being elected were: Emil Diewald, 1st Lt. P/R., Jim Holste, Lt. P/R., Carlos Bumzaham Lt. P/R., Jack Kleeman, Stg. P/R.

During the Fall semester of 1951-52 the commanding officer of the society was Capt. P/R Harry Hellmuth. I am sure that everyone will agree with me, that he is, and was one of the best officers P/R has ever known and an out-

(continued on page 34)

a discussion of the physical significance of stability . . .

Considerations

Every year, the student branch of the AIEE sponsors a technical papers competition. This year's district winner in the undergraduate division was Alfred H. Donahoe. The editors hope that by publishing Al's prize-winning paper, future aspirants will gain some insight into the writing of a technical paper.

This paper discusses the classical solution of the characteristic servo differential equation and the physical significance of the various possible root forms. Two methods, the Routh criterion and conformal mapping, are presented as devices for determining the existence of unstable roots without solving the characteristic equation.

In most of the physical situations involved in feedback control systems, a satisfactory degree of accuracy is obtained if the system is described with a set of simultaneous linear differential equations with constant coefficients. For this reason most of the development in the field of servo system analysis has dealt with this situation, that is with the linear case. There have been two avenues of approach to the problem. In the early literature, investigations were primarily concerned with a study of the transient behavior of the system and the resulting effects upon system stability or instability. More recently there has been a recognition of the similarity between the problems of system analysis and those encountered in the field of feedback amplifier analysis. This has resulted in an increasing tendency to use the steady state frequency response method of analysis, making use of the highly developed theory of feedback amplifiers.

However, both the steady state method and the various operational methods devised for the transient method have a disadvantage that is especially serious for a person just entering the field. Both steady state analysis and the operational methods of transient analysis greatly facilitate the determination of system characteristics, but in the process some of the physical significance of the various mathematical operations becomes obscured. It is for this reason that the author has returned to the consideration of the transient behavior as shown by the classical method of solution of the characteristic differential equations in order to gain an insight into the physical meaning of the mathematical examinations for instability.

Since a servo system can be satisfactorily described by a set of simultaneous linear differential equations with constant coefficients, it is theoretically possible to represent the system by a single equation in one dependent variable which will have the same mathematical

n a Servo System

by Alfred Donahoe, e.e. '52

characteristics as the set. That is, it will also be a linear differential equation with constant coefficients of the form shown below.

$$1.\ \frac{d^n x}{dt^n} + A_1 \frac{d^{n-1}x}{dt^{n-1}} + A_2 \frac{d^{n-2}x}{dt^{n-2}} + \ldots + A_{n-1}\frac{dx}{dt} + A_n x = F(t)$$

The complete solution of such an equation will completely describe the servo system response to any form of input function, F(t). Such a solution will be composed of two parts called the complementary function and the particular integral. The complementary function, when substituted into the equation as the dependent variable, has the property of causing the left hand side of the equation to become identically zero. The particular integral will be such that, when substituted as the dependent variable, it will cause the left hand side to become identically equal to F(t). It has been shown that the particular integral is a description of the steady state response of the system. That is, the condition that will be assumed when a infinite time has elapsed after the introduction of the input function. The present theory of steady state circuit analysis is based on this property. The complementary function has been found to describe the transient conditions that will arise during the period required for the system to again assume a state of equilibrium after the application of the input function.

Since the complementary function, when substituted into the equation, will reduce the left hand side to zero, it can be seen that this function will be a solution of the abridged differential equation obtained by setting F(t) equal to zero that is

$$2.\ \frac{d^n x}{dt^n} + A_1 \frac{d^{n-1}x}{dt^{n-1}} + A_2 \frac{d^{n-2}x}{dt^{n-2}} + \ldots + A_{n-1}\frac{dx}{dt} + A_n x = 0$$

From this it will be noticed that the complementary function and hence the transient characteristics of the system will be independent of the type of input function employed. The solution of this abridged equation must fulfill the requirement that the sum of the function and its first n derivatives, when multiplied by the constant coefficients of the equation, will be zero. This means that the complementary function must be such that the function and all of its n derivatives will have the same variation with respect to time. The only known function that has this property is the exponential function. Then if a complementary function of the form

$$3.\ x = Be^{at}$$

is assumed and substituted into the abridged equation, the result will be

$$4.\ \left[a^n + A_1 a^{n-1} + A_2 a^{n-2} + \ldots + A_{n-1}a + A_n\right] Be^{at} = 0$$

which is the product of three factors, the assumed B, the exponential e^{at}, and the polynomal in a. If either the constant B or the exponential e^{at} are equal to zero, the above expression will be zero, but both of these possibilities are trite solutions. The third possibility is for a to assume a value that will cause the polynomial to become identically zero.

From the theory of equations it is known that a polynomial of the nth degree will have (ignoring any possibility of multiplicity) n roots. There will be n values of a that will cause the polynomial to become zero. There are three possible forms the roots of this polynomial might assume: pure real, pure imaginary, or complex. Since for a physical system the coefficients $A_1, A_2, \ldots A_n$ will all be real numbers, the imaginary, and complex roots will always appear in conjugate pairs. In general, then, the complementary function will take the form,

$$5.\ x = B_1 e^{a_1 t} + B_2 e^{a_2 t} + \ldots \quad \ldots + B_n e^{a_n t}$$

and the number of arbitrary constants B will be equal to the order of the abridged equation. If the equation has m equal roots (root of multiplicity m), the function will assume the form

$$6.\ x = (B_1 + B_2 t + \ldots \quad \ldots + B_m t^{m-1})e^{a_1 t} + B_{m+1}e^{a_{m+1}t} + \ldots \quad \ldots + B_n e^{a_n t}$$

Further if a pair of complex roots of the form $a_1 = \alpha + j\beta$ and $a_2 = \alpha - j\beta$ occur, the following transformation will more clearly illustrate their physical significance

$$\begin{aligned} &B_1 e^{(\alpha+j\beta)t} + B_2 e^{(\alpha-j\beta)t} \\ &\quad = e^{\alpha t}(B_1 e^{j\beta t} + B_2 e^{-j\beta t}) \\ &\quad = e^{\alpha t}\left[B_1(\cos\beta t + j\sin\beta t) + B_2(\cos\beta t - j\sin\beta t)\right] \\ &\quad = e^{\alpha t}(C_1\cos\beta t + C_2\sin\beta t) \end{aligned}$$

For m pairs of equal complex roots the corresponding

(continued on page 22)

an experiment in learning . . .

THE CO-OP PLAN

by Bob Schrader, ch.e. '54

To students at any of twenty-odd universities the idea of an article on engineering cooperative schools may seem to be of little interest. "What's so unusual about a cooperative school," these students may say. "Our school has been co-oping for a third of a century, it's an engineering tradition." All this may be true, but to many students here at Illinois the idea of a co-op school is something new. This article will attempt to give these students an idea of what co-oping is all about. As examples of cooperative schools, we shall choose Cornell, Northwestern, Marquette, and Cincinnatti.

Cornell university sandwiches cooperative work in during summer vacations. Engineering is a five-year curriculum at Cornell, so the students begin work in industry in the summer following their sophomore year. This work is not required; it is purely voluntary on the part of the student. Also the student must be approved both by the industry in question and by the university.

The engineering curricula at Northwestern cover a five-year period and include eighteen months of practical work experience. The school year at Northwestern is divided into four quarters, counting summer school as one of the quarters. Students spend their freshman year and the first two quarters of their sophomore year entirely in classes. The summer between the freshman and sophomore years is a vacation.

The sophomore class is divided into two sections at the end of the second quarter. The first section of students begins work in industry. The second section remains in school and completes the full sophomore year. At the end of the spring quarter the two sections exchange places, with the students in section I leaving their industrial jobs and returning to school, and the students in section II beginning their industrial work program. This quarterly alternation between classes and work experience continues until the second quarter of the fifth or senior year. Both sections of students are in school during the last quarter prior to graduation. This setup is diagrammed for you in Fig. 1 on the opposite page.

Ordinarily students work in pairs to provide continuous coverage of one cooperative job throughout the year. While one member of the team is working, his alternate is in class. During his five years a student will complete twelve quarters in school and six quarters in industry.

Marquette's plan is very similar to the one at Northwestern, with the school year being divided into quarters, and the engineering student body into sections. There is an alternate four year non-coop plan at Marquette, however. Industrial firms working with the different universities are among the nation's finest. Included among Marquette's sixty-one cooperating firms are Allis-Chalmers Manufacturing Company, the Chicago, Milwaukee, St. Paul and Pacific railroad, General Electric, International Harvester, and Westinghouse Electric.

The cooperative course at the University of Cincinnati is of five year's duration, with a one-month vacation each year. The school year is divided into six terms of approximately eight weeks. Freshman students are required to attend school full time until the beginning of their fifth term. They then enter the cooperative program and continue on that basis until the second half of their senior year, when they return to school for full time attendance until graduation. The students are divided into two groups which alternate at the University and on the job every eight weeks. The satisfactory completion of eleven work periods is necessary to secure the Certificate for Cooperative experience.

The history of co-oping at Cincinnati is of especial interest, since that university is one of the pioneers in the field. Around the tur nof the century, "Herman Schneider, a young college instructor at Lehigh university proposed a simple and direct plan for bringing industry and education together. He believed that engineering students should be given both practical and theoretical training through alternate periods at college and at practical work. These periods, equal in length, would be comparable also in educational value, since each would represent a progressive sequence from the elementary to the more advanced phases of study and experince. The sequences would be planned to emphasize the inter-relations between the theoretical and practical aspects of engineering training.

Though direct contact with the processes and equipment of industry in actual operation, the student-worker would have the benefit of a complete and up to date laboratory of applied science, while industry would have the services of an alert, young employe, trained under practical conditions. During his work period, the student would receive pay at the standard rate and would otherwise have the status of a regular employe. Upon graduation from college, assuming that he made good and found the work congenial, he would

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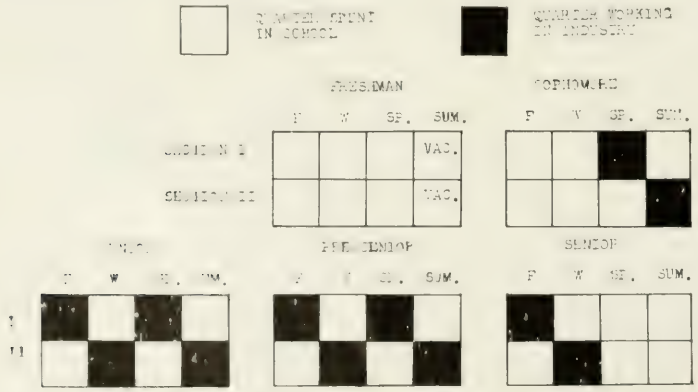

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introducing . . .

by Herb Gross, e.e. '55, Oliver Smith, m.e. '54
and Duane Loofbourrow, gen.e. '53

JOHN JOMBOCK

During the last great world conflict the Army of the United States realized the need for preliminary specialized training among its service men. As a result, it initiated a system whereby men, too young for the draft but graduated from high school, were sent to a college at the government's expense to receive basic engineering courses. Entitled "Army Specialized Training Reserve Program," it required that students pass an examination to make themselves eligible. This course provided

JOHN JOMBOCK

John Jombock with his initial engineering training and enabled him to get a valuable foothold in engineering before going into the service.

Born in Virden, Illinois, John attended both grammar and high school there, and upon completion of his secondary education he took the course offered by the ASTRP, mentioned above. When attaining the age of eligibility for the draft he was placed in the infantry in spite of the fact that he had specialized training. Jombock was transferred to the paratroopers when he completed his basic training and terminated his service in that branch.

After his discharge John had an aspiration of becoming an architect, so he enrolled at the Washington university in St. Louis. After completing two and one half years in architectural design, he discovered that he had interests in other fields of engineering. This was brought on in part by the summer work thata John did with the State of Illinois Division of Highways. He was employed in varied fields of work pertaining to inspection, surveying and construction during his summer vacation periods and thereupon became interested in civil engineering work.

In 1950 John transferred to the University of Illinois and began work in the hydraulic option of civil engineering. Finding structural option more attractive, he soon directed his interests in that sense. Structural option, by the way, deals primarily with the design of bridges and building frames.

Showing outstanding scholastic ability, John Jombock was elected to Chi Epsilon, Tau Beta Pi, and Sigma Tau, all honorary fraternities. As if this were not enough, this busy fellow went on to become the president of Chi Epsilon which is the civil engineer's own honorary. Also a member of ASCE, John is that organization's delegate to the Engineering Council. Much of the success of the recent St. Pat's ball can be attributed to John, because this friendly gentleman was the chairman of the committee in charge of the affair.

John has not made any definite decisions regarding post-graduate work, but he is carefully considering all of the offers made to him by employers during this, his last semester of undergraduate work.

PHILIP KENTON TRIMBLE

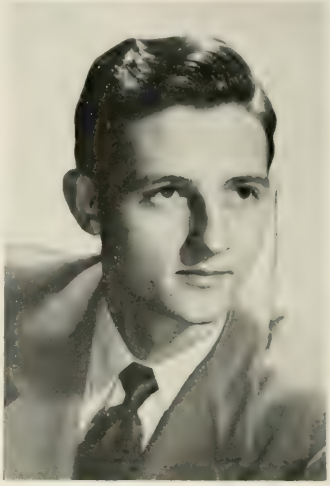
Philip Kenton Trimble, better known as Phil, is a senior in electrical engineering here at the University of Illinois. He hails from St. Joseph, Illinois, and had his prep training at the St. Joseph Community high school.

Phil is a member of Alpha Chi Rho social fraternity, but he has only lived in the house one of his eight semesters. The other semesters he has commuted between Urbana and his hometown.

While maintaining an almost perfect scholarship record at Illinois, Phil has also been very active in extra-curricular activities. He is Engineering Council Representative for the AIEE-IRE and serves as Treasurer of the Council. He must enjoy working with money (who doesn't) as he is also treasurer of the University Men's Glee Club. He got his musical training from trombone lessons and put them to good use playing in the University's Second Regimental band for four semesters.

Phil had a nice experience last month when he went with the Glee Club to sing with the Chicago Symphony Orchestra. From Chicago, he flew up to Detroit, Michigan, at the expense of General Motors and spent a few days there as the company's guest before flying back to Illinois. He has had many other job offers, but has not yet decided which one he will accept.

Many honorary fraternities have recognized Phil's enviable ability. He was initiated into Tau Beta Pi, honorary engineering fraternity, Phi Eta Sigma, freshman honorary fraternity, Pi Mu



PHILIP KENTON TRIMBLE

Epsilon, honorary mathematics fraternity, and he is national magazine reporter for Eta Kappa Nu, honorary electrical engineering fraternity.

Phil also enjoys tinkering with his Plymouth and playing intramural basket ball. With all this Phil still finds time to eat and sleep, which amazed this reporter.

The *Technograph* wishes the best of luck to Phil in all his future undertakings. If he does as well in the future as he has done in the past, we can expect to hear a lot more about this outstanding electrical engineer.

DR. JOHN D. RYDER

In the midst of his third year at the helm of the electrical engineering department, Dr. John Ryder is busily engaged in his many channels of activity, among which is the preparation for the formal dedication of the electrical

(continued on page 44)

Do you want a career with a future?

More and more of America's outstanding engineers are carving fine careers for themselves at Boeing. They've found a future here in an Engineering Division that's been growing steadily for over 35 years.

If you measure up, there's great opportunity here for you, too, and the rewarding experience of working on some of the nation's most vital programs such as the B-52 and B-47 jet bombers, guided missiles and other revolutionary developments.

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BOEING

skimming industrial headlines

edited by Charles LaRobadier, m.e. '55

radio-controlled airborne lifeboats

The completion of final acceptance tests on a new radio control for an airborne lifeboat that can be dropped by parachute from an airplane and unerringly guided to survivors in the water has been announced by Westinghouse.

An electrical control system that uses the radio signal from the air to control the engine and equipment for driving and steering the boat has successfully passed trial runs at Lake Pymatuning

This new automatic airborne lifeboat with fins is radio-controlled (Courtesy of Westinghouse)

and final tests conducted by the Air Force at Mobile, Alabama.

The control system for the lifeboat was designed around a radio transmitter-receiver set developed at Wright-Patterson Air Force Base, Dayton, Ohio.

After the 30 *ft.* long craft is dropped by parachute into the sea from the rescue airplane, radio signals at five different frequencies take over complete control in individual stages. The stabilizing fins that hold the boat steady as it leaves the plane are jettisoned. A guard protecting the propeller and rudder is freed. The engine air vents are opened. The motor is cranked up and automatically choked. Following this, the clutch is engaged and the throttle advanced to send the craft forward under the guidance of the radio controller.

When the lifeboat reaches the survivors, the airborne operator can bring it to a halt until the survivors board and then set the boat on its course again. If the physical condition of the rescued men is good, they can take over control of the boat themselves. If they are too weak for this, the airborne operator can guide them to shore or a rescue ship. The boat is equipped with triple controls, permitting passengers to break off radio control at any time and operate it electrically or manually.

"To activate the boat's power plant," explained Thomas A. Daly, managing engineer, "requires an electrical control system incorporating electronic amplifiers, relays, and actuators. Each signal is used to perform a specific group of functions, and the electrical system is so designed that it carries out each duty separately and in the proper order."

The first set of operations after the boat strikes the water consists of five separate stages described above. The radio signal controlling these functions is transmitted to the boat at a frequency of 955 cycles a second. Another radio signal—this one at 3000 cycles a second—now goes into action. The gear shift is advanced from neutral to forward and at the same time the throttle is advanced to halt speed. To turn the boat left, a radio signal of 650 cycles acts on the magnetic compass steering mechanism. For a right turn, a signal of 300 cycles is used. For emergencies, a fifth frequency of 1390 cycles is used. A push-button control is also available.

The 3500 *lb.* craft can hold 15 men, with provisions for 10 days and fuel for an 800 *mi.* cruise. It is also equipped with "walkie-talkie" radio sets for boat-plane communications, a machine for distilling fresh drinking water from sea water, and a protective canopy.

radar raincoat

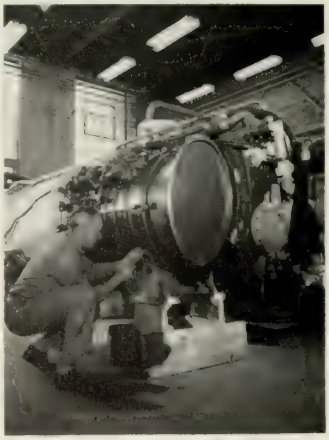
Radar equipment can be protected by a huge, balloon-like radome. The purpose of the rubber-fabric radome is to protect the radar antenna from wind snow, and ice, without hindering its operation. An aluminum framework is used to raise the huge balloon, which is 167 *ft* in circumference and 36 *ft* high After the balloon is inflated to one twentieth of a pound of air pressure, the framework is lowered into the floor. When inflated to a half pound of pressure, the radome will withstand winds up to 125 *mph*. Special infrared lamps trained on the walls keep the radome free of ice and snow. Entrance is through an air lock chamber.

a solid, high-temperature lubricant

Molybdenum disulfide is a superior lubricant for moving parts that operate too hot for ordinary oils and greases. It can be used readily at temperatures up to 700°F, and in some cases, even up to 2100°F for short periods and in inert atmospheres. Formerly available only in the form of powder, in a water suspension, or as an additive to greases, it can now be had in solid or stick form. The molybdenum sulfide, with a slight amount of phenolic binder, is molded into desired solid form by heat and pressure. Sticks or brushes of molded lubricant can be held by spring pressure against the rotating member so that some of it is wiped onto the hot surface.

wooden jet

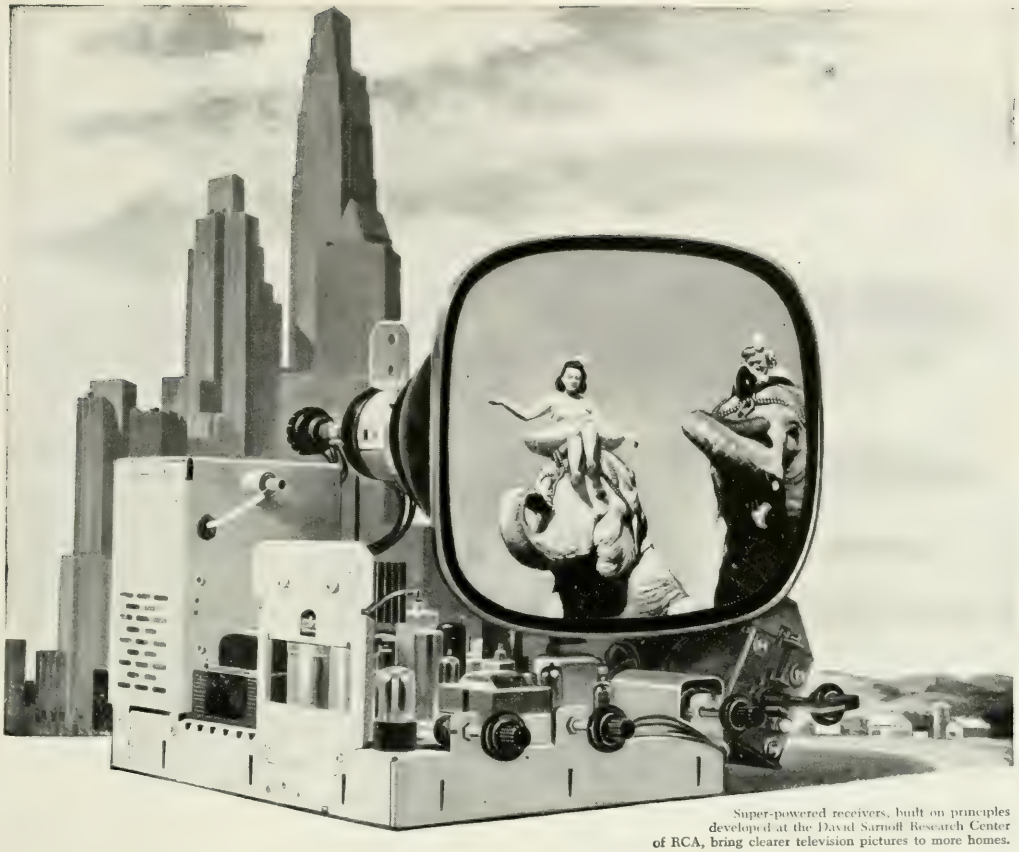
Wood, glue, and screws are virtually the only materials in the mock-up J-40 jet aircraft engine being built by Westinghouse. The model is a precise replica



Wooden model of jet engine facilitates allowances in design alterations. (Courtesy of Westinghouse)

of stainless steel and aluminum engines that are now in quantity production for the U. S. Navy. The wooden engine enables airplane designers to make the

(*continued on page* 40)



Super-powered receivers, built on principles developed at the David Sarnoff Research Center of RCA, bring clearer television pictures to more homes.

New Super Sets widen television's horizons!

Although no new TV stations have been built since 1950, television's reach has been extended *in two ways*. In sections of cities where interference is a problem, fine pictures can now be seen The same is true in rural, or TV "fringe" areas, formerly too distant for clear reception.

RCA engineers and scientists, to offset these limitations, developed powerful new Super Sets. In distant fringe areas, these sets boost a weak or faltering signal into a clear, steady picture. While in cities, where buildings and electrical devices may interfere, this same super power—plus television's first double-shielded tuner—bring in TV at its best. The result is stronger pictures in the country and in problem areas, and better pictures than ever before in areas of normal television reception.

The new RCA Victor "Picture Power" Super Sets are examples of research and engineering at work for your benefit. This pioneering means finer performance from all products and services of RCA and RCA Victor.

* * *

See the latest in radio, television, and electronics in action at RCA Exhibition Hall, 36 West 49th St., N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y.

CONTINUE YOUR EDUCATION WITH PAY—AT RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey. **Also many opportunities for Mechanical and Chemical Engineers and Physicists.**

RCA *RADIO CORPORATION OF AMERICA*

World leader in radio—first in television

(continued from page 15)

terms in the complementary function would be

$$B_0 + B_1 t + \ldots \quad \ldots + B_{m-1} t^{m-1} e^{\alpha_0 t}$$
$$+ C_0 + C_1 t + \ldots \quad \ldots + C_{m-1} t^{m-1} e^{\alpha_0 t}$$

which by the above transformation could be written

$$e^{\alpha t} [D_0 + D_1 t + \ldots \quad \ldots + D_{m-1} t^{m-1}] \cos \beta t$$
$$+ E_0 + E_1 t + \ldots \quad \ldots + E_{m-1} t^{m-1}] \sin \beta t$$

A pair of imaginary roots can then be seen to assume the form

$$B_0 e^{j\beta t} + B_0 e^{-j\beta t} = C_1 \cos \beta t + C_2 \sin \beta t$$

and in the case of a pair of imaginary roots of multiplicity m, the final form would be

$$(B_0 + B_1 t + \ldots \quad \ldots + B_{m-1} t^{m-1}) \cos \beta t$$
$$+ (C_1 + C_2 t + \ldots \quad \ldots + C_{m-1} t^{m-1}) \sin \beta t$$

In the preceding discussion it was shown that if the polynomial in a appearing in equation 4) has a real root, there will appear a corresponding term in the complementary function of the form $B_1 e^{(\alpha_1 + j_0)t}$, for each pair of complex roots, a term of the form $e^{\alpha t}(C_1 \cos \beta t + C_2 \sin \beta t)$; and for each pair of imaginary roots, a term of the form $C_1 \cos \beta t + C_2 \sin \beta t$. Then considering the physical significance of these various types of terms, it can be seen that if there exist a pair of pure imaginary roots, the response to any sort of disturbance to the servo system will be an oscillation that will remain constant in amplitude with time. Since this condition is for most uses as undesirable as a response that will increase with time, for most applications such a root will be classed as indicating instability.

A pair of imaginary roots occurring more than once will produce a term of the form $f(t)C_1 \cos \beta t + g(t)C_2 \sin \beta t$ which indicates that any sort of system disturbance will produce oscillations whose amplitude will increase with time. This situation will be considered as unstable for any application.

In all the cases where a root of the polynomial of equation 4, contains a real part, the role of the exponential $e^{\alpha t}$ will be dominant in determining whether or not the disturbance will disappear with time. So for any case where the root contains a real part, it is not necessary to consider the possibility of multiple roots. If the root has a negative real part, the corresponding term in the complementary function will contain as a factor $e^{-\alpha t}$ and the system disturbance that this term represents will be such that it will decay with time. On the other hand, a root with a positive real part will represent a disturbance whose amplitude will increase with time.

Perhaps it should be remarked at this time that when the statement is made, that an amplitude will increase with time, this is only strictly true as long as the assumption of linearity can be made to apply. Once the amplitude of the disturbance has increased to the point where the behavior of the system parameters has become non-linear, the amplitude will be governed by the non-linear behavior of the parameters. In any event such a situation is distinctly undesirable in a servo system.

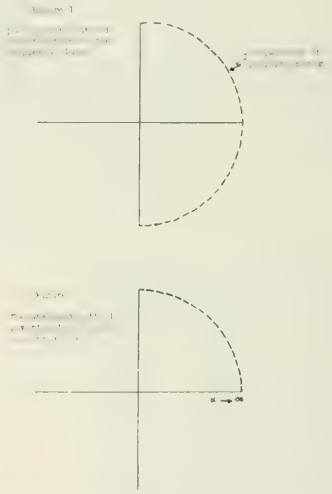
From the standpoint of the classical analysis of transient behavior, the problem of determining the stability of a servo system resolves into the problem of examining the polynomial of equation 4 for roots that are either pure imaginary or that have positive real parts.

If the degree of the polynomial in a is three or less, the most direct approach would be to solve the equation and determine the roots. However, in most servo systems the resultant polynomial in a will be of a degree greater than three and in some cases considerably greater than three. In such cases a direct solution becomes impractical and recourse must be made to one of the various mathematical schemes devised to determine the presence of pure imaginary roots and roots with positive real parts.

Edward J. Routh, in a book published in 1859, outlined a simple test for determining the sign of the roots of a polynomial. If the coefficients of the polynomial of equation 4 are arranged in the following manner and the tables constructed in the manner shown until the final row contains only one element, the Routh criterion of stability can be applied.

A_0	A_2	A_4
A_1	A_3	A_5
$B_1 = A_1A_2 - A_0A_3$	$B_2 = A_1A_4 - A_0A_5$	$B_3 = A_1A_6 - A_0A_7$
$C_1 = B_1A_3 - A_1B_2$	$C_2 = B_1A_5 - A_1B_3$	. . .
$D_1 = C_1B_2 - B_1C_2$	. . .	. . .

Then all the roots of the polynomial will have negative real parts if the coefficients A_0, A_1, A_2, . . . A_n are positive and all the calculated terms B_1, B_2, . . . ; C_1, C_2, . . . ; D_1, D_2, . . . ; etc. are positive or zero.



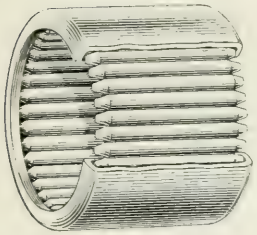
There exists another method of examining the polynominal of equation 4 for the presence of roots whose real part is either positive or zero. This method is called conformal mapping and is a development of the theory of complex functions. Stated in general terms, the idea of conformal mapping is this. Let z be a complex variable of the form $Z = x + jy$ and let w be a single valued functional relationship such that $w = f(Z) = u(x,y) + jv(x,y)$. Now if, and only if, the function w is analytic when it is defined as $w = f(z)$ will it satisfy the Cauchy-Riemann differential equations,

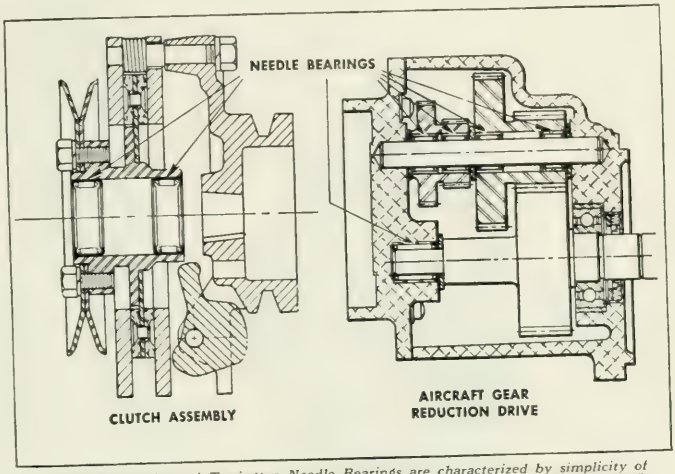
$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y} \quad \text{and} \quad \frac{\partial v}{\partial x} = -\frac{\partial u}{\partial y}$$

Further, let R be the region of the complex z plane for which $w = f(z)$.

(continued on page 30)

The Torrington Needle Bearing needs little space—saves time in assembly





Typical installations of Torrington Needle Bearings are characterized by simplicity of design. Needle Bearings are made for shafts as small as 5/32" up to those as large as 7 1/4".

The Torrington Needle Bearing is a completely self-contained unit consisting of a full complement of small diameter rollers and a single retaining shell. This unit design and construction greatly simplify handling and speed assembly, and help reduce the size and weight of related parts.

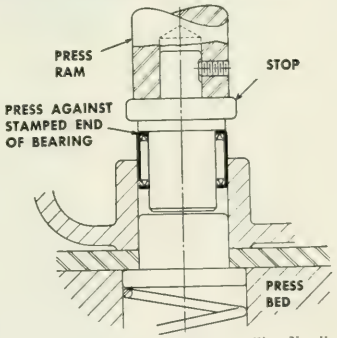
High Load Capacity in Small Space

Because the many rollers distribute loads over a large contact surface, a Needle Bearing has a very high load capacity in relation to its size. In fact, the Torrington Needle Bearing has a higher rated radial load capacity than any other type of anti-friction bearing of comparable outside diameter. This not only permits the use of a smaller, lighter bearing for a given load, but also allows reductions in the size and weight of housings and other related components. The Needle Bearing's large inside diameter permits larger shafts to be used in cramped quarters, an important factor in many designs.

Installation Simplified

The installation of Torrington Needle Bearings is fast and easy. The housing bore is simply machined to proper diameter. The bearing is then pressed into this housing. An arbor press is normally used for this operation. No spacers or retainers are needed to keep the bearing in place. An accurately made shaft is required, of course, as it serves as the inner race in most cases and must be hardened and ground to correct size. For applications where an unhardened shaft is desired or necessary, inner races can be furnished for all Needle Bearings.

These advantages make Torrington Needle Bearings ideal for applications where space or weight is at a premium, or where mass production methods necessitate the use of a bearing that is as easy as possible to handle and install.



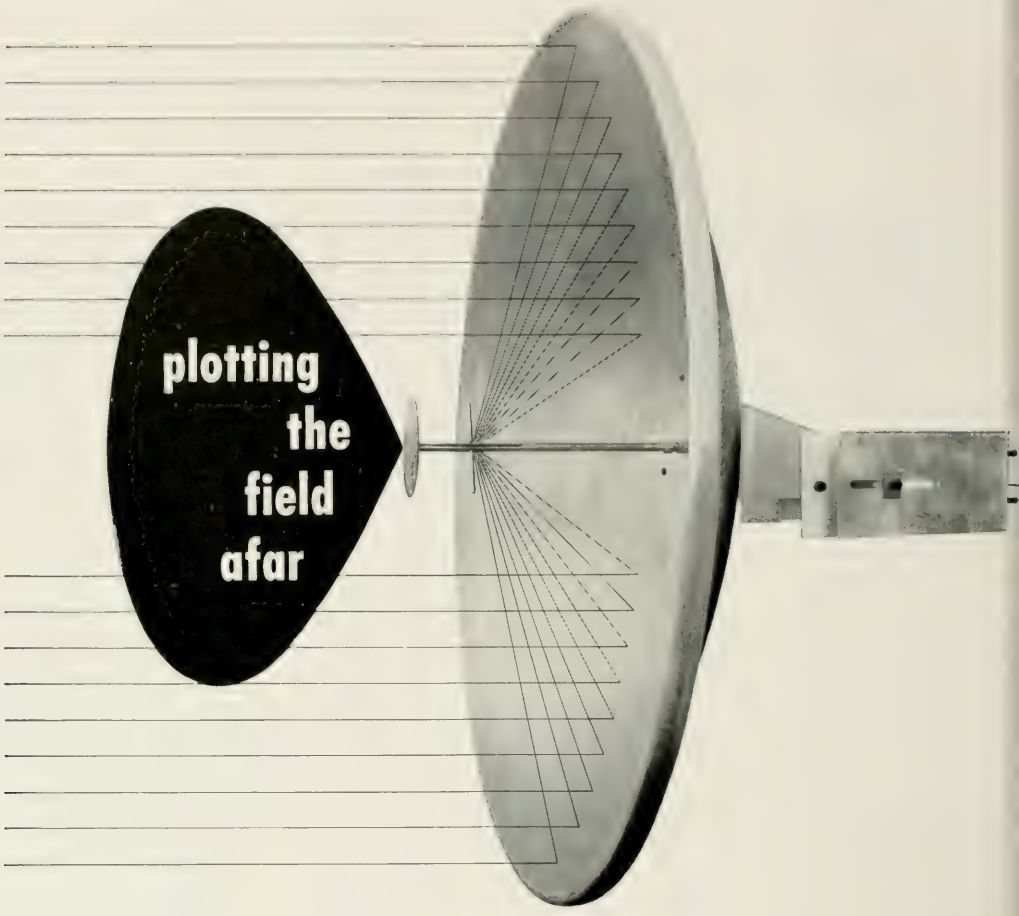
The use of proper tools for installing Needle Bearings speeds up assembly. The arbor press tools above are ideal.

Other features of Torrington Needle Bearings will be covered in other advertisements in this series. For additional information regarding Needle Bearings, please contact our engineering department.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON *NEEDLE* BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS



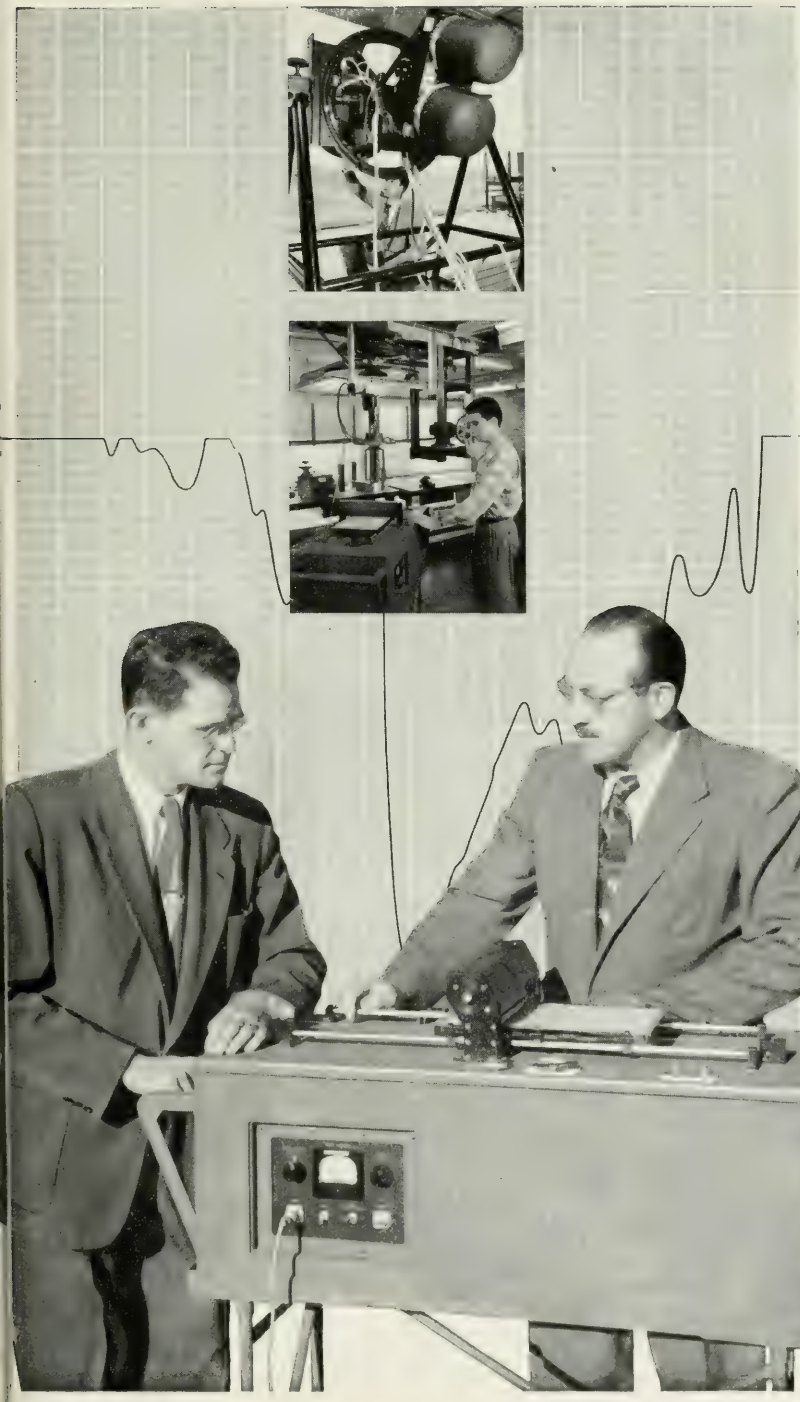
Plotting the radiation pattern of a microwave antenna is typically time consuming and laborious. For some time, workers in this field have felt a need for a continuous non-manual means of performing this operation. The extensive microwave activities of its Research and Development Laboratories have created at Hughes a special interest in such automatic pattern-measuring equipment.

The first automatic machines that were at all accurate were of the fixed location type and weighed nearly a ton. The new Hughes recorder weighs just one hundred pounds, is more accurate, and has higher writing speeds than the earlier machines. Its recording range covers 80 decibels in the audiofrequency spectrum. The writing speed is approximately 25 inches per second, with an 8"x11" plot, and the abscissa or angle scale is controlled by an electrical take-off system.

In the field of microwave measurements, this machine assists in determining many things — such as the correct shape of reflectors and the proper location of feeds. The development of such improved laboratory tools is an interesting by-product of a large research activity, such as that conducted by the 3500 men and women of the Hughes Research and Development Laboratories.

The growing requirements of both the commercial and military electronics programs at Hughes are creating new positions within the Research and Development Laboratories. Graduate students and senior men are cordially invited to address correspondence to:

Hughes Research and Development Laboratories
Engineering Personnel Department
Culver City, Los Angeles County, California



Plotters. *O. A. Tyson (left) and Dr. L. C. Van Atta worked together in developing this new machine at Hughes Research and Development Laboratories.*

by Bob Schrader, ch.e. '54 and Warren Brandt, c.e. '54

Well, readers, this month you get a break. I imagine that after a year and a half you are getting pretty tired of my Bilge. So, this month I take a vacation. Let's go back and see what some of the Bilge writers before my time had to say. This first joke, excuse me, I mean anecdote, comes from the original Bilge column written in October, 1949.

Dr. Comings, high pressure man in the ChE department told the following to his victims in thermo last spring.

One day while making the rounds of his ark, Noah was taking census of the animals aboard. After finding seventeen rabbits, five squirrels, three giraffes, etc., he came upon two lonely snakes—the same ones he had brought aboard.

"Why haven't you multiplied like the other animals on the ship?" asked Noah. "We're adders," was the simple reply.

As the original Barnum continued his rounds he noticed the shortage of furniture for his horde. After summoning his old friend, P. Bunyan, Noah built some crude-looking log chairs and tables.

Three days after installing them aboard the ark, he was suddenly confronted with a family of five snakes. "But I thought you couldn't multiply!" he blurted.

Happily papa snake replied, "We used your new log tables."

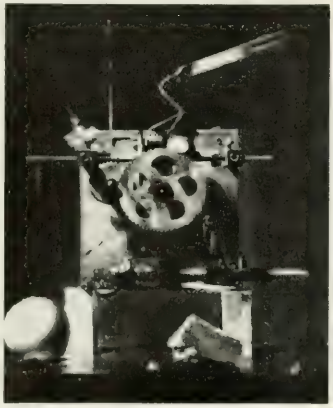
* * *

THE ART OF SLEEPING IN CLASS: It is a fairly well accepted fact that engineers get less sleep than any other students. To make up for this lack of nocturnal bliss, the student must resort to some other means. The most practical solution is to sleep in class. This method is frequently practiced and has thus become an art.

The most practical time to sleep is during a lecture. It will frequently be found advisable to take a seat near the rear of the room where you may black out unnoticed by the instructor. (Some inconsiderates have definite ideas as to seating arrangement.)

One problem in this particular case is that of keeping the note book or clipboard on the desk. The object may easily slide to the floor, thus requiring an unnecessary amount of energy to retrieve it at the end of the period. Also, certain people receive tremendous pleasure from accidentally pushing a clipboard to the floor. The clipboard lands with a resounding clatter, waking both instructor and students. I have found that resting either an arm or the head on the memorandum usually will help.

The position to be assumed for napping will vary with the type of seat in the classroom. I suspect that many chairs were designed for the express purpose of keeping the student awake. The backs of most chairs are so constructed that resting the head on the back (of the chair) is the best solution. This, however, presents the possibility of snoring.



Walter T. Murch's "The Motor" won a Purchase Award at the University's recent 1952 Exhibition of Contemporary American Painting.

Sleeping with the arms supporting the head may result in disaster. I nearly lost my head once.

In classes where discussion prevails, other problems arise. Instructors in such classes may object to this state of activity. A friend of mine has solved this problem by learning to sleep with his eyes open, a process which I have not yet mastered.

It may be embarrassing to come to just as the instructor is asking you a question. Robert Benchley, in an essay on "Dozing" suggested a reply of, "Well . . . I . . . don't . . . know." In the classroom, however, this may be of little or no help.

M.E.'s and C.E.'s may find it extremely difficult to sleep in drawing rooms. The stools are most uncomfortable. It may even be necessary to sleep while standing. A roving instructor will not help matters any.

For the novice, it may be necessary to spend a few nights with less than the usual ten hours sleep to get into form. Pills guaranteed to keep you awake will help to induce sleep. Though the are may never be fully perfected, one should not become discouraged, for even the cruder methods will produce the desired results of lengthening one's doze period.

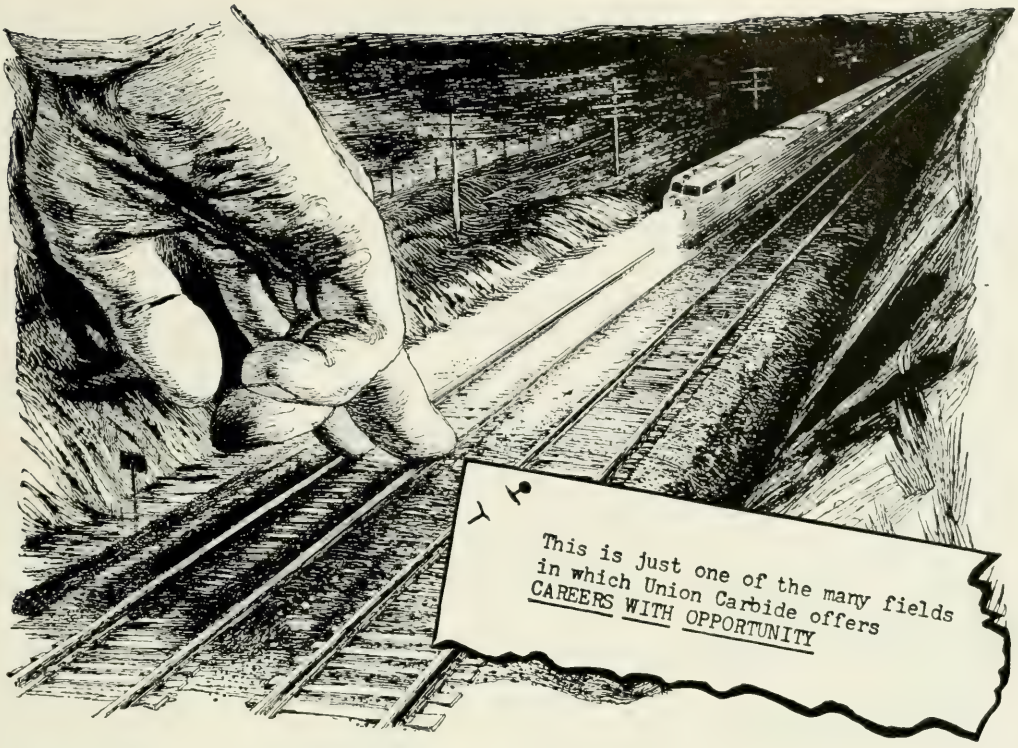
* * *

TIME MAGAZINE COMMENTS ON TECH SPEAKER

No stranger to the *Technograph* is Prof. Eugene I. Rabinowitch, U. of I. physical chemist and Editor of the *Bulletin of the Atomic Scientists*. Professor Rabinowitch addressed the 1951 *Tech* banquet, but his greater fame lies in his editorship which arose from his participation in the A-bomb project while at the University of Chicago.

Time magazine in its 21 April issue has characterized the *Bulletin of the Atomic Scientists* as a sort of 'voice

(continued on page 28)



Clearing the track of clickety-clack

You can ride in comfort on longer-lasting rails because the song of the track is being stilled

Like the paddleboat whistle on the river, the clickety-clack of wheels on rails is on its way to becoming a memory.

This familiar clatter and chatter has been like music to some of us when we travel. But it's been a headache to others . . . particularly our railroads.

Wheels pounding on rail joints cause jolting and wear as well as noise. And wear means expensive repair or replacement of rails and the bars that connect them.

ELIMINATING RAIL JOINTS—"Ribbonrail" is becoming important news because it provides a way to solve the high cost of joint maintenance by eliminating the joints themselves.

RAILS BY THE MILE—"Ribbonrail" is formed by welding the rails together under pressure in the controlled heat of oxy-acetylene flames. The welding is done on the job before the rails are laid . . . and they become continuous ribbons of steel up to a mile or more in length.

Mile-long lengths of rail in use may seem impossible because of expansion and contraction under extreme changes in weather and temperature. "Ribbonrail" engineering has solved this problem . . . reduced rail maintenance cost, and created the comfort of a smoother, quieter ride.

A UCC DEVELOPMENT—"Ribbonrail" is a development of the people of Union Carbide. It is another in the long list of achievements they have made during 40 years of service to the railroads of America.

STUDENTS and STUDENT ADVISERS

Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of ALLOYS, CARBONS, CHEMICALS, GASES, and PLASTICS. *Ask for booklet B-2.*

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BILGE . . .

continued from page 26

crying in the wilderness," the wilderness being the general public apathy to the A-bomb and other problems arising from the progress of science including restrictions on scientific freedom. *Time* is quick to point out that the *Bulletin* is read and quoted by a great number of prominent thinkers around the globe. Its subscription list includes forty in the countries behind the Iron Curtain including the USSR. The *Bulletin*'s editorial board features such prominent names as J. Robert Openheimer, Harold C. Urey and Albert Einstein.

Rabinowitch himself has crusaded through the *Bulletin* for free exchange of scientific information and the *Bulletin* speedily got into action to force a lifting of U. S. Commerce Department's restrictions on the mailing of U. S. scientific and technical publications to foreign addresses. Russia's Vishinsky proclaiming agreement with freedom of scientific information exchange with the West, but charging the West and particularly America with obstructing this freedom, brought this comment from Rabinowitch, "We challenge Mr. Vishinsky and the editors of the Moscow *News* to protest the Soviet restrictions on the mailing abroad of Russian scientific journals as vigorously as American scientists have protested the American counterpart; and we hope they will succeed as promptly and as completely as we did on our side."

Bringing to light the cultural and social implications of the bomb and scientific progress is Professor Rabinowitch's aim through the *Bulletin*, a readable, soft paper job, tailored for the general public; and the *Technograph* is happy to approve heartily of this vital, timely project on international problems that must be mastered if world peace is to be a reality.

* * *

TECHNOGRAPH RIDES THE LAST OF THE JUICECARS

The *Technograph* officially represented by its Illustrations Editor, Warren H. Brandt participated in the final run of the Illinois Terminal Railroad's train operating westward out of Danville. The railroad terminated operations on the line between De Long Station and Danville and ran the last train Saturday 26, April, 1952. Brandt accompanied, by his friend, Art Eggers, grieved the loss of this important connection with the Twin Cities, Urbana-Champaign.

One hundred and fifty railfans and a few regular commuters were aboard and were greeted by scores of photographers at each station of the abandoned line. Abandoning railroads seems to be a step backward though, doesn't it?

From Professor Alexander of our Chemistry Department we quote the following words which we feel can relate to many of our subjects: "Teaching organic chemistry is like pouring H_2O into a sieve. The only hope is that it will run out slowly enough to last through each hour exam.

* * *

One of the E.E. profs here was heard to make the following enlightening statements:

An LAS student knows nothing, and he can do nothing.

A math major knows everything, but he can do nothing.

An engineer knows nothing, but he can do everything.

A commerce student knows nothing and can do nothing, but he gets paid for it.

A true music lover is a person who, when he hears a soprano in the shower, puts his ear to the keyhole.

* * *

It's almost old-fashioned now to believe in love at first sight, or even love at first marriage.

HEAP BIG HUNTING GROUND FOR HAPPY SLIDE RULES

On the Campus

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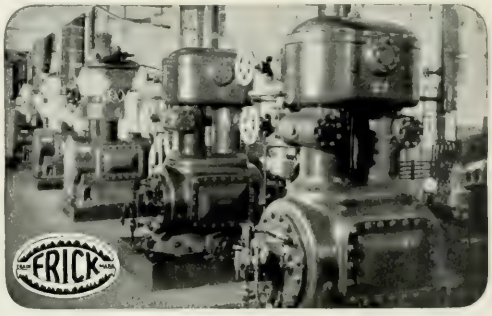
U. OF I.



Snow Crop Marketers Install Frick Refrigeration

Snow Crop Marketers, a Division of Clinton Foods, Inc., and one of the largest packers of quick-frozen foods in the country, has in operation at Lewiston, Idaho, a battery of five large Frick compressors which produce temperatures as low as minus 40 degrees F. Installation by Lewis Refrigeration and Supply Co., Frick Sales-Representatives at Seattle.

Super-dependability and economy have made Frick refrigerating machines the favorite with quick-freezers, as well as in air conditioning, ice making, and other cooling systems.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years offers a career in a growing industry.

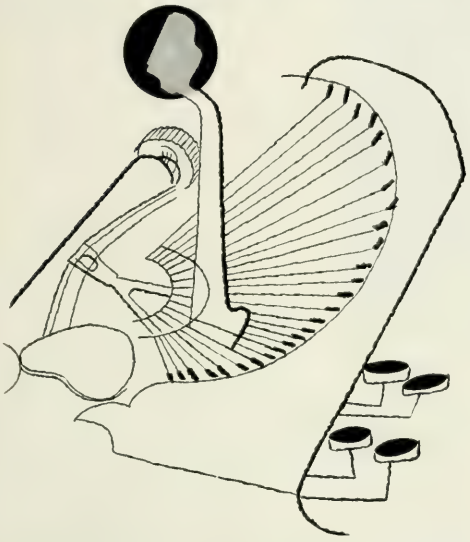
DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA., U.S.A.

What's Happening at CRUCIBLE

about special shape type steel



5. The flash trimmed off after the swadging operation.

6. The finished type ready for hardening, plating and soldering to the type bar.

The production of Crucible steel for this job is the result of engineering and practical know-how combined with a special method of manufacture to assure a homogeneous microstructure for maximum forming properties, excellent surface characteristics for good die life, and close accuracy control for all dimensions of the shape.

The production of type steel requires the use of small precision rolling mills equipped with shaped rolls and operated by skilled workmen. During preliminary and final inspection, shadowgraph equipment is constantly used to check for size accuracy.

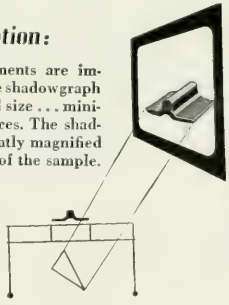
As a result of its outstanding quality, Crucible's special shape type steel is constantly in demand and used by leading typewriter manufacturers.

Crucible special purpose steel for type character application

The development of cold rolled special shape type steel is one of Crucible's important contributions to the business machine industry. A major part of the type characters used for the manufacture of typewriters are made from this special shape.

Shadowgraph Operation:

Since micrometer measurements are impractical due to the shape, the shadowgraph is used to measure shape and size . . . minimum and maximum tolerances. The shadowgraph is a projection, greatly magnified . . . on a calibrated screen . . . of the sample.



Schematic of shadowgraph

Here's the step-by-step process:

1. Cold rolled special shape produced by Crucible.

2. The type slug cut from the special shape material.

3. The wings of the type slug are bent down and taper formed toward the edges.

4. The type characters are cold swadged on the solid edge of the bent type slug.

If you have a requirement for special steels—check with Crucible. Feel free to draw on the experience of our metallurgists and engineers. Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

52 years of Fine steelmaking

Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

SERVO SYSTEM . . .

(continued from page 22)

Then the functional relationship $w = f(z)$ sets up a correspondence between the points $z = x + jy$ of the complex z plane, and $w = u + jv$ of the complex w plane. If $w = f(z)$ is analytic for the region R of the z plane, for each value z in the region R the corresponding value of w will lie in a region R' of the w plane. If C is some curve drawn in the region R and the point z is allowed to move along C, then the corresponding point w will trace a curve C' in the w plane. Then if the curve C is drawn in R so that it is a closed curve that encircles in a positive sense a value of z for which $w = 0$, the corresponding curve C' will encircle the zero point of the w plane in a positive sense. The positive sense for a boundary curve C of a region is such that the region will always lie to the left of the curve when proceeding in the positive sense. Further, if the curve C is made to encircle more than one value of z for which $w = 0$, the corresponding curve C' in the w plane will encircle the zero point once for each value of z so enclosed by C. If the curve includes as one of its points a value for z for which $w = 0$, then the curve C' will pass through the zero point of the w plane once for each such value of z.

It can be shown that the polynomial occurring in equation 4 will be analytic over the entire complex z plane. Then the theory of the preceding section can be applied directly to the polynomial in a. The path C is chosen to be the path shown in figure 1, that is, the imaginary axis and a semi-circle of infinite radius that will enclose all finite values of a with positive real parts. Let the polynomial be defined to be $w = f(a)$. Then if a conjugate pair of pure imaginary roots of f(a) exist, the curve C' will pass through the zero point

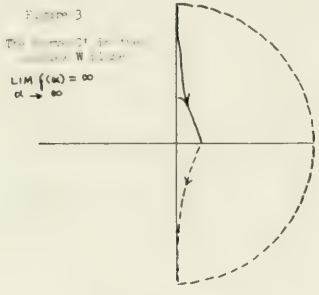


Figure 3

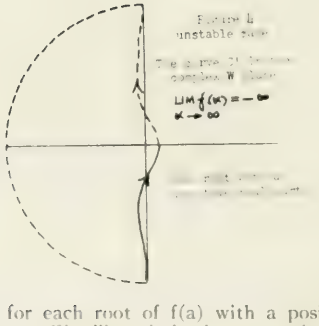


Figure 4
Unstable case

twice, and for each root of f(a) with a positive real part, the curve C' will encircle the zero point once in a positive sense.

Since it has been previously remarked that any complex or imaginary roots will occur in conjugate pairs, it can be seen that the portion of the curve C' that is traced when a ranged over the values along the imaginary axis will be symmetrical with respect to the real axis. Thus it would be sufficient to investigate the behavior of the curve C' for a ranging from zero to positive infinity. Further, since for any infinite value of a the function f(a) will be infinite, the location of the portion of C' resulting when the infinite semi-circle portion of C is traced could be established by substituting $a = \alpha + j0$ in f(a) and determining whether $\lim_{\alpha \to \infty} f(\alpha)$ equals positive or negative infinity. The accompanying figures 2, 3, 4, 5 and 6 give the probable shape of the plots illustrating each of these situations.

At the beginning of this paper it was assumed that the simultaneous set of n differential equations describing the servo system could be reduced to a single

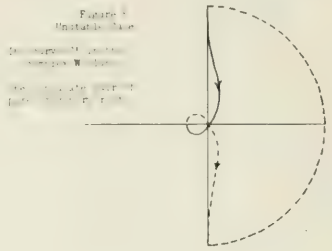
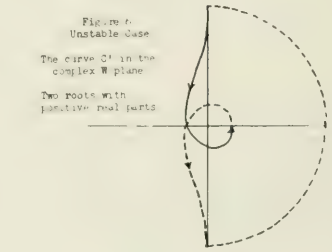


Figure 5
Unstable case



characteristic equation with the same mathematical properties. It is not necessary to do this. If instead an exponential solution is assumed for each abridged equation of the set, the result will be a set of n simultaneous equations each of the general form of equation 4. If the determinant of this set,

$$\begin{vmatrix} a^n & A_{11}a^{n-1} & \cdots & \cdots & A_{1n-1}a & A_{1n} \\ a^n & A_{21}a^{n-1} & \cdots & & . & A_{2n} \\ . & . & & & . & . \\ . & . & & & . & . \\ . & . & & & & . \\ & & & & & \\ . & . & & & & . \\ . & . & & & & . \\ . & . & & & & . \\ a^n & A_{n1}a^{n-1} & \cdots & & \cdots & A_{nn} \end{vmatrix}$$

is expanded it may be examined for roots whose real parts are positive or zero in the same manner described for the polynomial of equation 14.

In conclusion, the author wishes to acknowledge the advice and guidance of Mr. L. O. Brown, of the electrical engineering staff of the University of Illinois.

What Are They?

- ☐ *Thrust bearings*
- ☐ *Clutch disks*
- ☐ *Grinding wheels*
- ☐ *Ceramic insulators*

The correct answer is grinding wheels, shown as they emerge from the electric kiln.

Not ordinary grinding wheels, however. They are Norton *New-Process* Wheels — made by modern, streamlined, precision methods developed by Norton engineers.

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This increased uniformity means extra assurance of consistent grinding action throughout each wheel and from wheel to wheel. Which, in turn, means more evenly wearing, longer lasting wheels — together with more cutting action per wheel and per dollar.

In addition, the built-in balance of Norton *New-Process* Wheels cuts down vibration and enables them to hug the work more closely, assuring smoother, better grinding performance.

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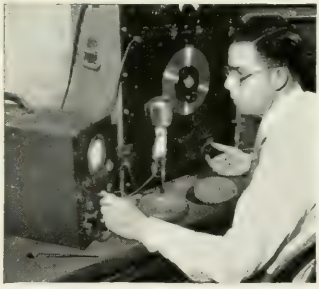
Recent Norton literature gives further details on this important advancement in grinding wheel manufacture and performance. Write for your free copy.



John J. Amero, M. S., Cer. Eng., North Carolina State '38, checks duplication of grinding wheel grade with the aid of an oscillograph. John has been working on the development of Norton "New Process" wheels.

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EE DEPT . . .

(continued from page 11)

the solution of complicated electrical networks. In this country, power distribution systems are interconnected from east of the Rocky Mountains to the east coast. This presents a vast, extremely complicated network which would be impossible to solve using manual methods. The network analyzer shows the effects on the whole system of adding a load, such as a factory, or cutting out a generating station.

The network analyzer here at the University is the largest of its kind in any educational institution. The only larger such unit is owned by General Electric and is located in Schenectady. To cut down the size of the elements used in the analyzer and also to reduce its power consumption, it is operated at a frequency of 10,000 cycles per second, as compared with 60 cycles as furnished by power companies. A factory can be represented by an inductive load, that is, a load composed of coils. Since the magnitude of the load represented by any given coil is directly proportional to the frequency, it can be seen that a much larger load can be represented by a coil at 10,000 c.p.s. than by the same coil at 60 c.p.s.

The analyzer was designed by Dr. John D. Ryder, head of the department, and Professor Max A. Faucett. It is one of two 10,000 cycle analyzers, the other being designed by Dr. Ryder for Iowa State college.

Since the machine provides solutions to simultaneous equations, its usefulness is not confined to electrical networks, but it will also be used for fluid flow problems and stress analysis.

There are 389 electrical engineers enrolled in the department's three options, most of these in the electronics and communications option. Electrical engineers here at the University take the common program for freshmen as do other engineers, and all options take a common program the second year. In their junior year, the E.E.'s begin to branch out into their individual options, the power men concentrating more on power machinery, transformers, and the like, while communications men study networks, lines, electronics, and radio circuits.

The illumination men get some architecture courses, many lighting courses, some power machinery and electronics. Sales management and psychology are also required in this option.

Besides handling the three E.E. options, the electrical engineering department offers courses to non-electricals who must take some electrical engineering courses. These include M.E.'s, Aero. E.'s and others. Special courses in DC circuit analysis and electrical measurements are offered to these students.

Research in the department is conducted largely by a special research staff. Some of these men conduct lab courses in the department, but their main work is research.

At present, research is being conducted in several fields. Television field strength measurements are being made, and the effects of antenna design are being investigated. Miniature vacuum tube research is being conducted in the research laboratory.

One interesting field of study concerns the effects of large eddy currents on concrete reinforcing bars. Modern power plants are handling larger and larger amounts of current. These larger currents induce extremely high magnetic fields and the fields in turn set up currents in the surrounding structural steel. In some cases, these so-called eddy currents are so high as to heat up the reinforcing bars in concrete to the point where they become structurally unsound. Research in this field will attempt to solve these problems brought about by the increased power handling capacities of present-day generating stations.

Research is being conducted to find out the effects of ground potentials on

(continued on page 42)

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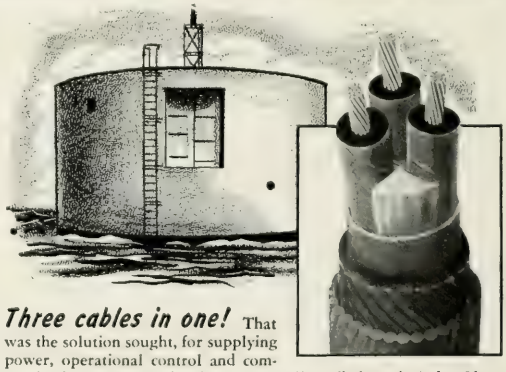


Three cables in one! That was the solution sought, for supplying power, operational control and communication to a pumping house 4½ miles off shore in Lake Okeechobee, Florida.

As usual, Okonite engineers were consulted on the problem. Their studies showed that it was possible to combine a three-fold function in one cable. This was accomplished by the use of Okolite high-voltage insulation whose electrical characteristics permitted carrier current to be superimposed on the power conductors.

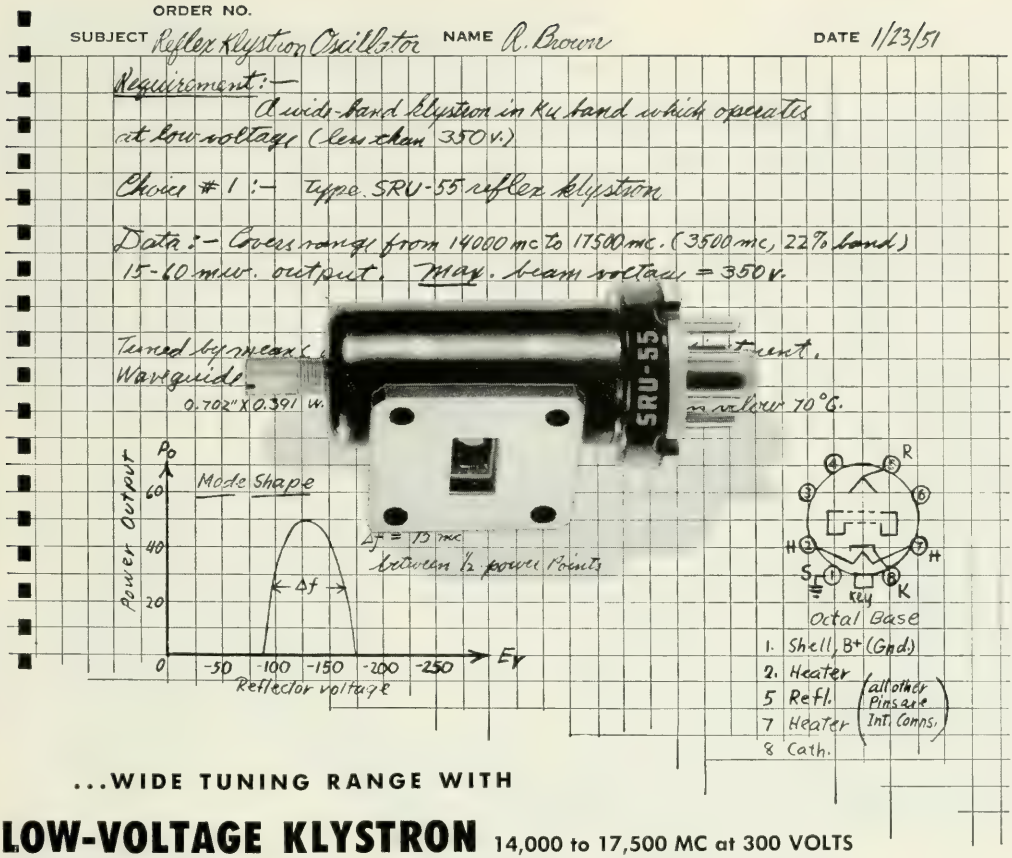
The result was a single Okonite-insulated cable — steel-armored for the 4½ underwater miles, with a non-metallic sheath for an additional 2½ miles underground — which supplies not only power and operation control, but a communication circuit as well.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE *insulated wires and cables*

8787



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Keep Learning — But Start Earning ... at Sperry

The klystron tube described here is but one of the many Sperry Klystrons which has resulted from Sperry's sponsorship of the development of the klystron in 1939. From Sperry laboratories have also come a complete line of Microline* instruments for precision measurement in the entire microwave field. In these labs career-seeking engineers keep learning but start earning—work with acknowledged leaders in their fields—do interesting, creative, important work—find the opportunity for advancement as high and broad as their own capacity for improvement.

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NAVY PIER . . .

(*continued from page 13*)

standing cadet. Harry Hellmuth has transferred to the downstate campus company I chapter 5.

During the last semester the society has initiated 14 new members.

This semester the society plans to enter a drill squad downstate, at the Illinois invitational drill meet.

This semester the society has planned to bring in some new members. For this reason the membership committee was set up. Dale Smith is the chairman of the membership committee and pledge master. The other men on the committee are Bill Edwards and Anatol Longinow.

The P Rs are on the lookout for likely pledges who are really interested in the R.O.T.C. Those who might be interested may ask any P R member more about it. (P Rs are identified by the blue and white fourragère in their shoulder loop.)

SAME

The student chapter of the Society of American Military Engineers has successfully progressed from its stage of infancy in the fall semester to a smooth running organization. Through the work of the officers, Clifton Zabka, president; John Curtis, secretary; Richard Krammerer, vice president and treasurer, and a close knit organization which has backed them, a rather fine program has been scheduled, with several of the events having already been completed.

Cooperation from E. J. Gress, Chief of Personal, Great Lakes District Engineers, has enabled the society to see several movies dealing with a number of the waterways in the United States and also to hear an informative lecture on taconite, an iron ore bearing rock. The Spring Carnival here at the Pier presented a fine opportunity for the club to enlarge its funds. This was done very profitably, thereby placing the society in a rather solvent state.

During the Easter recess, the society members and other interested students visited the U. S. Steel plant in South Chicago. A fine insight into industry was gained by this tour. In mid-May election and installation of new officers, plus the initiation of new members is to take place during a semi-formal dinner, at which several speakers will be present. To complete this well-rounded program, an outing for members and friends will take place soon after finals.

"Is that man rich?"

"Is he! He's so rich he doesn't even know his son's in college."

CAMP RABIDEAU . . .

(*continued from page 12*)

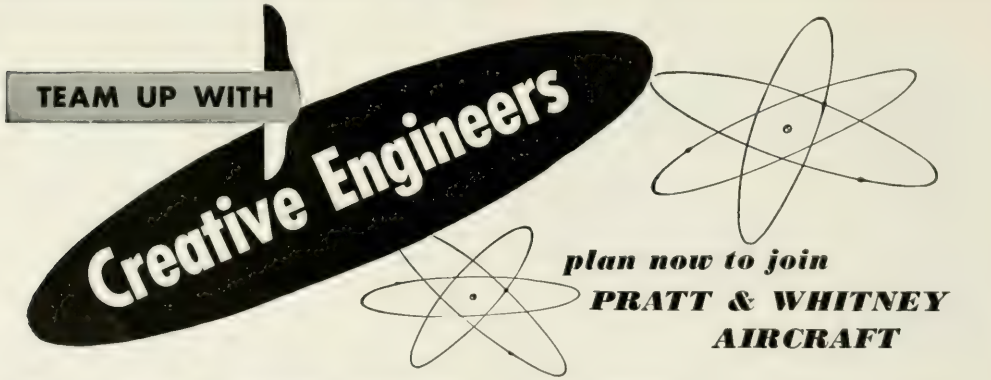
camp and students frequently take side trips to those that are near. These include the headwaters of the Mississippi River at Lake Itasca State Park, Cut Foot Sioux experimental forest, a beautiful stand of pine down Grand Rapids way, and the border cities of International Falls, Minnesota and Fort William, Ontario.

All in all, as a surveying camp, Camp Rabideau turns out a pretty good assembly of surveyors, almost a hundred each summer, but it turns out a goodly number of baseball players, fishermen, and swimmers too.

A student leaving the camp has not only learned surveying but has learned how to accommodate himself to a new and unique experience that is just a little bit different from anything he has come across previously. Without a doubt anybody that has been to Camp Rabideau will tell you he is richer for it and has learned one of the most practical subjects offered in any engineering school.

Co-ed: "Is it natural to shrink from kissing?"

Prof: "If it were, my dear, most of you girls would be nothing but skin and bones."



FOR over a quarter of a century the Pratt & Whitney Aircraft Division of United Aircraft Corporation has depended upon *creative engineering* to bring its products to the forefront.

How well this idea has worked is amply demonstrated by the outstanding leadership record which Pratt & Whitney has established in both piston and turbine aircraft engine types.

And for the future, because of its sound engineering background and research facilities, Pratt & Whitney is one of the few companies in the country to be selected to develop an atomic powered engine for aircraft.

Creative engineering will continue to be given top emphasis at Pratt & Whitney—and it might well be the best answer to *your* future too—if you want a chance to put *your own* ideas to work.

Why not find out where you could fit into this great engineering organization? Consult your Placement Counselor or write to Frank W. Powers, Engineering Department at

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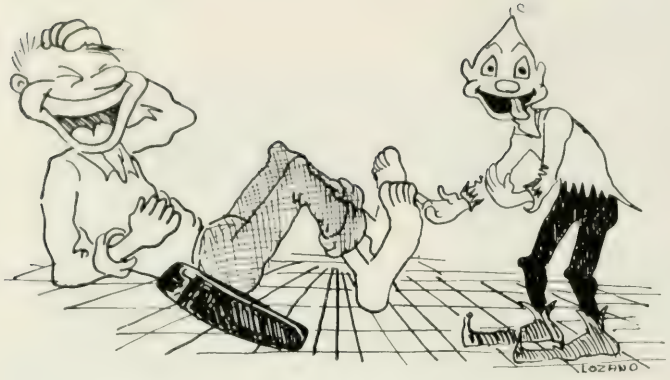


TECHNOCRACKS

edited by Mary Donley

A motor cyclist, in an effort to keep warmer, put his coat on backwards so that the back would better protect the chest. As he sped down the highway a car dashed across his path from a side road and the cyclist was thrown into a ditch. The police soon came along and one of them attended the prostrate cyclist.

"How is he?" asked one cop.

"What a shame!" replied the other. "The poor lad had his head turned around. By the time I got it straightened out he was dead."

* * *

A young theologian named Fiddle
Refused to accept his degree.
For, said he, it's enough to be Fiddle
Without being Fiddle, D.D.

* * *

Doris: "I can't marry John, father. He's an atheist and doesn't believe there's a hell."

Father: "Go ahead and marry him, Doris, you'll convince him."

* * *

"Son, after four years of college, you're nothing but a drunk, a loafer and a damn nuisance. I can't think of one good thing it's done!"

The son was silent a moment. Suddenly his eyes brightened. "Well," he said, timidly, "it cured Ma of bragging about me."

* * *

Senior: "Gee, I'm thoisty."

Frosh: "Wait a minute, I'll get you some water."

Senior: "I said thoisty, not doity."

A canny Scot was engaged in an argument with the conductor as to whether the fare was to be five or ten cents. Finally the disgusted conductor picked up the Scot's suitcase and tossed it off the train just as they were crossing a long bridge. It landed with a mighty splash.

"Hoot, Mon," screamed Sandy. "First you try to rob me and now you've drowned my little boy!"

* * *

Police sergeant: "College student, eh?"

Prisoner: "Yes, sir."

Patrolman: "It's a stall. I searched his pockets and found money in them."

* * *

A maid in the land of Aloha
Got caught in the coils of a boa.
Like arms the snake squeezed,
And the maid not displeased,
Cried, "Go on and do it Somoa!"

* * *

Something to think about:

If we could only sleep as soundly at night as we do when it's time to listen to a lecture.

* * *

Dear Pop,

Everything fine at school. I'm getting lots of sleep and am studying hard.

Incidentally, I'm enclosing my fraternity bill.

Your son,
Pudge.

Dear Pudge,

Don't buy any more fraternities.

Your Pop,
Pop.

I noticed in "Time" that Jacob Horner, a survivor of the battle of the Little Big Horn, died. It seems he survived because he wasn't there.

* * *

There had been an accident. It was the old thing—a student's convertible had collided head-on with the farmer's Model A. The two drivers got out and surveyed the damage. "Well," said the farmer, "we may as well have a drink." He hauled out a bottle and passed it to the student who gulped down a stiff one. The farmer calmly returned the bottle to his pocket. "Aren't you going to have one?" asked the college student. "Don't believe I will," was the answer, "until the police have checked up."

* * *

"Just because my eyes are red is no sign I'm drunk. For all you know, I may be a white rabbit."

* * *

Professor (after the final exam): "Well, what did you think of the course?"

Student: "I thought it was very all-inclusive. Everything that wasn't covered during the year was covered on the final exam."

* * *

A Sultan at odds with his harem
Discovered a way he could scare 'em.
By catching a mouse
Which he freed in the house,
Thus causing the first harem scarem.

* * *

A co-ed trying to maneuver her car out of a parking space banged into the car ahead, then into the car behind, and finally, pulling into the street, struck a passing delivery truck. A policeman who had been watching approached her.

"Let's see your license," he demanded.

"Don't be silly, officer," she said. "Who'd give ME a license?"

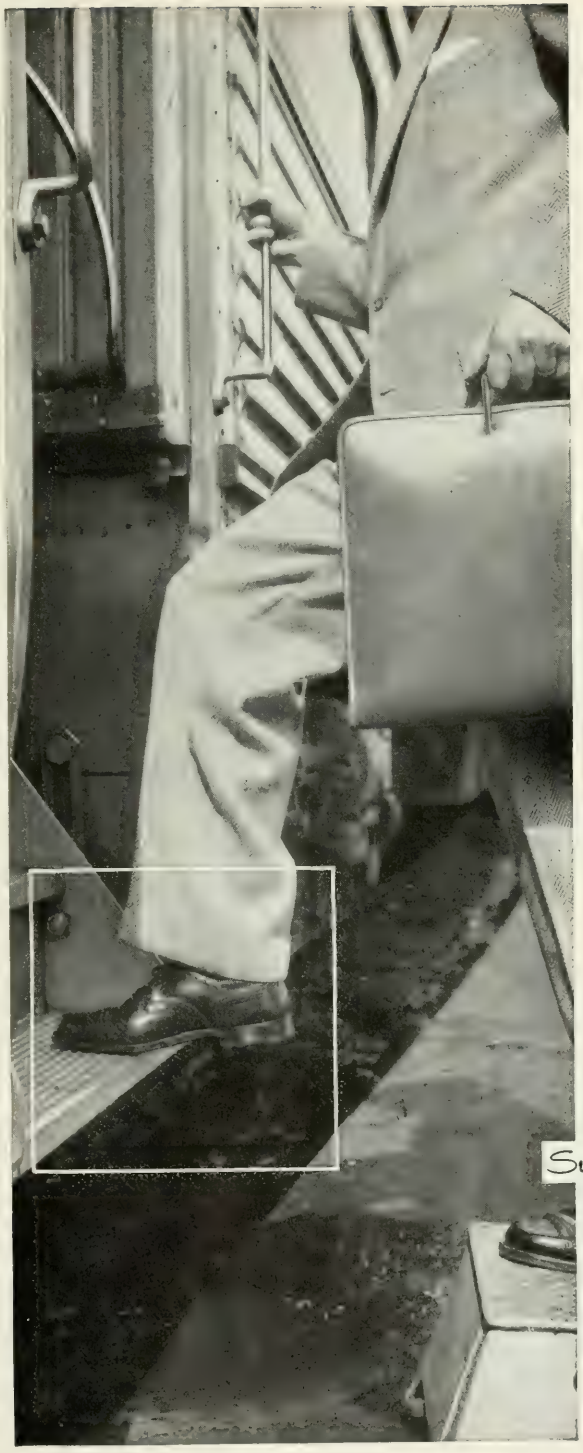
* * *

Trying to rest after an exceedingly hard day at the office, poor father was being bedeviled by a stream of unanswerable questions from little Willie.

"What do you do down at the office?" Willie finally asked.

"Nothing," shouted the annoyed father.

After a thoughtful pause, Willie inquired: "Pop, how do you know when you're through?"



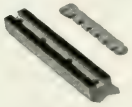
APPOINTMENT WITH TIME

When you travel by train (or, for that matter, by plane or any public carrier) you expect to arrive on time. Unconcerned, you click-click across switches in the yard district . . . swish past the clang of grade crossings . . . roar by freights only a few inches away . . . Your confidence lies in experienced railroaders and properly maintained roadbeds and signal equipment.

Over every mile of track, your safe and speedy progress is guarded. Guarded by semaphores, position and color light signals, dwarf signals, automatic train controls, interlocking control machines in far-away towers, and other elements in an all-inclusive safety pattern.

An *unseen essential* in this safety pattern, reliable and hard-working, is *Synthane.* Synthane is a strong, light-weight, laminated plastic. It's an excellent electrical insulator, moisture and chemical-resistant, hard, tough and dense. It is also easy to machine. Synthane is a material for small parts or large on any job where a combination of properties is needed and good performance is a "must".

Maybe you can use Synthane profitably. To find out, send for the complete Synthane catalog. We will be glad to help you with design, sheets, rods, tubes or fabricated parts. Synthane Corporation, 10 River Road, Oaks, Pennsylvania.



Terminal Board (left) for continuous train control and relay pusher (right). Both pieces are made from Synthane laminated plastics for General Railway Signal Co., Rochester, N. Y.

Synthane—one of industry's unseen essentials

SYNTHANE

LAMINATED PLASTICS

I am Industry-1952

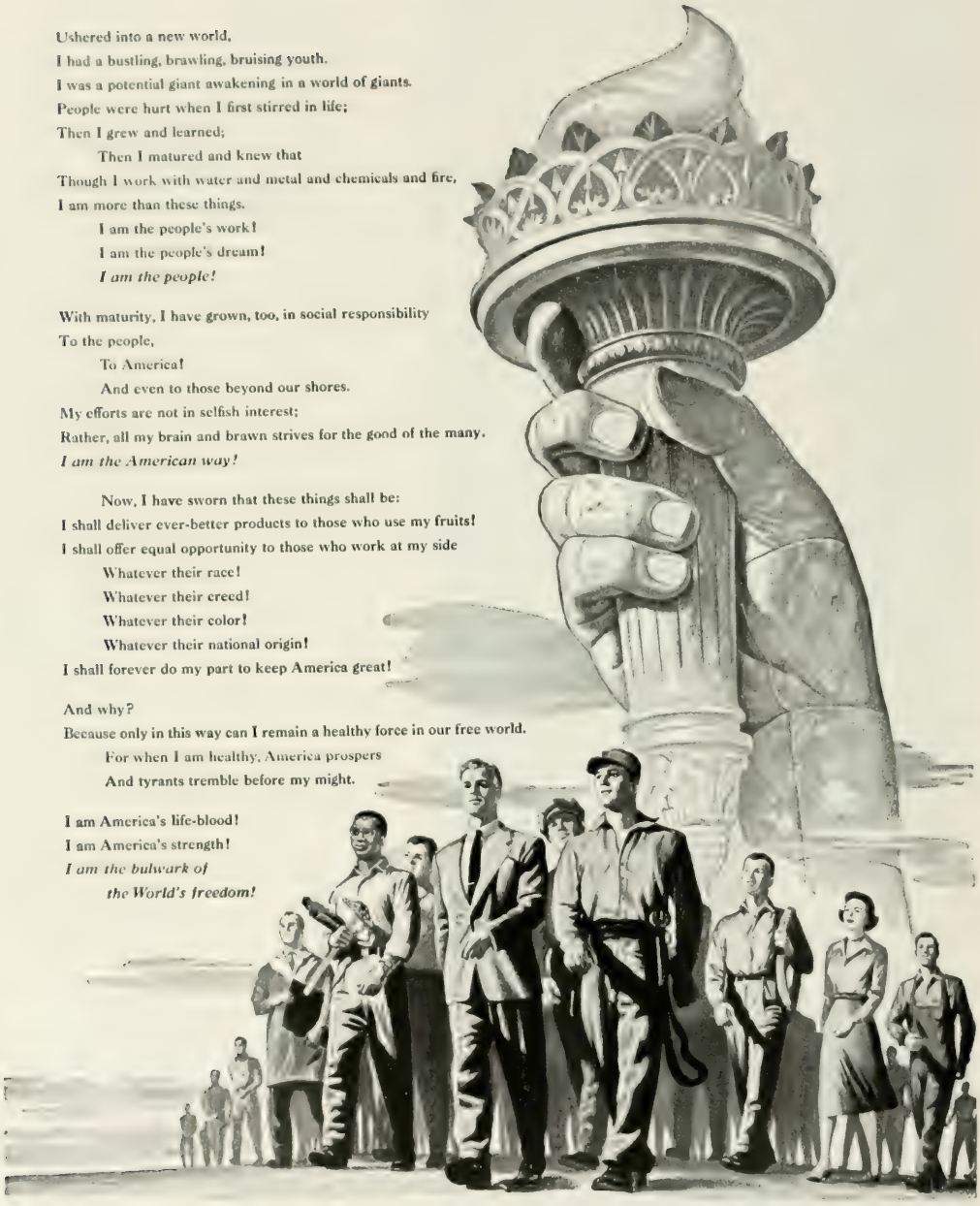
Ushered into a new world,
I had a bustling, brawling, bruising youth.
I was a potential giant awakening in a world of giants.
People were hurt when I first stirred in life;
Then I grew and learned;
Then I matured and knew that
Though I work with water and metal and chemicals and fire,
I am more than these things.
I am the people's work!
I am the people's dream!
I am the people!

With maturity, I have grown, too, in social responsibility
To the people,
To America!
And even to those beyond our shores.
My efforts are not in selfish interest;
Rather, all my brain and brawn strives for the good of the many.
I am the American way!

Now, I have sworn that these things shall be:
I shall deliver ever-better products to those who use my fruits!
I shall offer equal opportunity to those who work at my side
Whatever their race!
Whatever their creed!
Whatever their color!
Whatever their national origin!
I shall forever do my part to keep America great!

And why?
Because only in this way can I remain a healthy force in our free world.
For when I am healthy, America prospers
And tyrants tremble before my might.

I am America's life-blood!
I am America's strength!
I am the bulwark of
the World's freedom!



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how large?

The 40- to 75-foot trademarks of a world-famous Thanksgiving Day parade are inflated with helium. Lighter-than-air, this "safe" gas will not burn or explode.

how small?

From the eye-bright yellow "Mae West" to the life-saving raft of an Air Force pilot, CO_2, one of the family of Airco gases adds to the safety of American airmen everywhere.

at the frontiers of progress you'll find

AN AIR REDUCTION PRODUCT

Big as a balloon . . . small as cartridge ampule, the range for needed gases is only one segment of the innumerable operations that link the Airco corporate family to many basic activities of American life — and industry . . . a corporate family that depends upon each individual member for its strength.

What is the strength behind Airco? — air and its constituent gases, plus the wide range of companion products that contribute to the comfort and convenience of daily life . . . from anesthesia to aircraft construction . . . from plastics to shipbuilding. In fact, wherever progress is racing ahead to new frontiers, you'll find an Air Reduction product.

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60 EAST 42nd STREET • NEW YORK 17, N. Y.

Divisions of Air Reduction Company, Incorporated, AIR REDUCTION SALES COMPANY, AIR REDUCTION PACIFIC COMPANY, AIR REDUCTION MAGNOLIA COMPANY . . . *Industrial Gases, Welding and Cutting Equipment* • AIRCO EQUIPMENT MANUFACTURING DIVISION • NATIONAL CARBIDE COMPANY . . . *Calcium Carbide* • OHIO CHEMICAL & SURGICAL EQUIPMENT CO., OHIO CHEMICAL PACIFIC COMPANY . . . *Medical Gases — Apparatus — Hospital Equipment* • PURE CARBONIC COMPANY . . . *Carbonic Gas and "Dry-Ice"* • AIRCO COMPANY INTERNATIONAL . . . *Export* • AIR REDUCTION CHEMICAL COMPANY

CO-OP PLAN . . .

(continued from page 16)

become a full time, instead of a half time worker.'

There are many advantages to the cooperative system. Since a younger man is more willing to ask questions, practical experience is more readily assimilated in the formative student years. Also the cooperative student frequently brings to class observations gleaned from his shop experience, resulting in a better understanding of the material covered in class. At graduation the student frequently remains with the firm with which he cooperated, or in other cases, his work record is of advantage in establishing a new connection.

Post graduate and cooperative training programs overlap to a considerable degree, thus materially shortening if not eliminating, the post graduate training period. The cooperative system is a very valuable financial aid in completing an engineering education. This system also enables students, mistaken as to their vocation, to change their objective without serious loss of time.

All this may be well, but what do the students themselves think of the system? This question was partially answered in a survey made on two hundred and eighteen engineering students by the Rochester Institute of Technology. First of all the students were asked if cooperative work made their schoolwork more meaningful. Seventy-eight per cent of the students said that cooperative work had made their schoolwork clearer. Similarly 74 per cent of the students said that their interest in school had increased because of on-the-job training.

This poll also brought out some of the weaknesses of cooperative plans. Coordination between the school and the job could be improved. The length of the work block or of the school year itself disturbed some of the students. Cooperative methods of instruction also were criticized, and the heavy class schedule necessitated by cooperative work was pointed out. Also, more social contacts are needed for the student on co-op.

It has not been the purpose of this article to determine whether cooperative or non-cooperative schools present the better form of engineering education. Each individual must decide this by weighing the merits of his own special case. However, it is well to remember that cooperative, as well as non-cooperative engineering schools exist today in America, and that there is definitely a need for both of them.

SKIMMING . . .

(continued from page 20)

necessary allowances for size, accessories, and other problems involving the engine's configuration. The wood construction—aside from being inexpensive—also makes it easy for the model shop to keep the engine up to date as its forms evolves from the engineer's calculations.

newly developed automatic pilot

An automatic pilot designed to relieve U. S. Navy fliers of 90 per cent of their "stick and rudder" work was announced recently by General Electric. The device was described as a major step toward complete push-button control of high-speed jet interceptor planes.

Engineers said the new autopilot "does just about everything a human pilot can do except actually take the plane off the ground and land it," controls the plane with accuracy and stability at near-sonic speeds, and can be used in such maneuvers as gunnery runs on enemy aircraft.

Designated the G-3, the autopilot was developed by the GE Aeronautic and Ordnance Systems Division in cooperation with the Navy Bureau of Aero-

(continued on page 42)

Engineering Graduates

CONSIDER YOUR FUTURE IN AIR CONDITIONING

WITH TRANE

Trane, a leading manufacturer of air conditioning, heating, ventilating and heat transfer equipment, is seeking qualified engineering graduates for interesting careers with its sales and home office staff.

Those selected will join the Trane Graduate Training Program at La Crosse for an intensive training course that will prepare them for responsible positions in La Crosse or in one of the company's 80 sales offices. The training period is financed by the company to make the trainee self-supporting.

Men who have completed the Trane Graduate Training Program have established an interesting pattern of success with the company. Included in this number are the president and numerous other company officers, managers of a majority of the sales offices and home office sales divisions.

Trane has continued to grow steadily and at a rate consistent with financial stability. Annual sales have increased fourfold in the last ten years. Yet, the company continues to develop new products for new fields to increase its potential business opportunities.

Based on past record and future possibilities, Trane offers you outstanding opportunities in one of the fastest growing industries. For more information write for the brochure "The Trane Graduate Training Program." It contains full details as well as a complete financial report of the company.

THE TRANE COMPANY
LA CROSSE, WISCONSIN

SAVE!

Illinois Technograph Subscriptions

8 ISSUES FOR ONLY $1.25

(clip this coupon)

The Illinois Technograph
725 South Wright Street
Champaign, Illinois

Please enter my subscription for eight issues starting October, 1952.

☐ Remittance enclosed.

☐ Please bill me later.

Offer expires August 30, 1952

You are giving away your standard of living

FANATICS in Germany, India, even some in America, say we should scatter our billions over the world in order to use up our surplus; otherwise (they say) it will dam up on us and cause a depression.

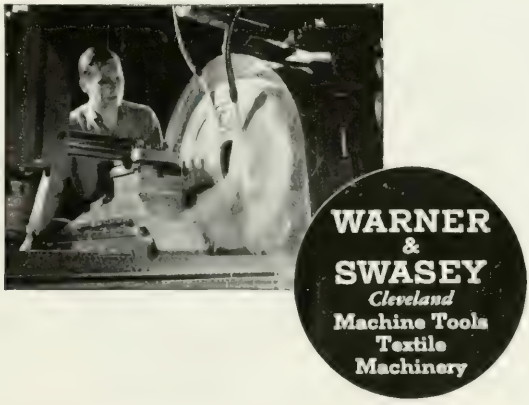
It is entirely possible that we should give away those billions for humanitarian reasons—that is another matter. But don't let's let greedy foreigners and stupid Americans say we're doing it for our own selfish interests. And don't let anyone of us think we are doing it by "soaking the rich". We are giving away (and, remember, perhaps we should, so long as we do it with eyes open) our standard of living.

You and I work, not for dollars but for what those dollars will buy. The more *things* there are in America, the more your day's work and mine will buy. The more steel there is in America, the more automobiles you can get at a low price. The more cloth, the more suits you can own. The more food there is, the better you and your family will eat.

There can only be so much of those things. When you ship them away; you do without. You seldom ship *money* abroad; money is only a token of exchange for the *things* that are going out of this country, out of your reach.

Perhaps that's good, perhaps that's wise. But we should realize what we're doing. Whatever we give away abroad comes out of what we have at home. Unless, of course, each of us produces that much more at his machine or plow or desk *every day.*

If every one of us *produces* more efficiently we can have the satisfaction of knowing we are doing something for the world without destroying America . . . the one strong hope of the world. If we "share the wealth" with the world, we will soon be sharing nothing but poverty. If we share our *increased production* and demand increased production in return, there will then be wealth *and* strength to share.



YOU CAN MACHINE IT BETTER, FASTER, FOR LESS WITH WARNER & SWASEY TURRET LATHES, AUTOMATICS AND TAPPING MACHINES

SKIMMING . . .

(continued from page 40)

matics. It was designed for use in high speed Navy jet fighters.

The G-3 will hold the plane automatically at the desired barometric altitude, heading and attitude. The pilot can put the plane through the maneuvers he wishes by means of push buttons and a miniature control stick which moves under finger-tip pressure. When the human pilot wants the autopilot to take over, he pushes a button and the device holds the airplane at the same heading and altitude it was in when the button was pushed. By means of another button, the pilot can change altitude, turn in either direction, or climb and dive.

The G-3 is also used as a "yaw damper" during manual flight to stabilize the airplane and improve steadiness.

Non-tumbling gyros permit the plane to maneuver through complete loops and rolls without disabling the gyroscopes through tumbling.

The G-3 system consists of a G-2 compass, a vertical gyro and a rate gyro which feed electric signals into an amplifier. The amplified signals are then applied to one or more of three motor-driven actuators which move the airplane's control surfaces.

Researchers check purity of hydrocarbons by determining freezing points. (Courtesy of Westinghouse)

air conditioning for greater accuracy

Elimination of variables in precise measurement techniques was a big problem in the addition to the Engineering Hall at Carnegie Institute of Technology in Pittsburgh. Herein is located

(continued on page 48)

EE DEPT . . .

(continued from page 32)

underground cables. The resistance of the earth varies with the composition in different parts of the country. Electrical energy is capable of traveling through the ground, and these ground currents and voltages affect underground telephone cables and coaxial cables for TV transmission.

The research staff recently completed ORDVAC, the calculating machine purchased by the army, and are now engaged in making another for the use of the University. The machine is a digital computor and can handle calculations in a matter of hours and sometimes minutes that would take a mathematician several years to complete.

The department has been awarded research contracts by the government war and navy departments. This research is confidential, but it is known that some of it is along servo-mechanisms lines. Servos are the devices which power the control surfaces of large planes in response to the touch of the pilot.

That the University is turning out electrical engineers, and good ones, is testified to by the fact that at last count, there were 1.3 companies requesting interviewing time for every available graduating senior. Many other companies have been denied interviews because there just aren't enough men.

According to one professor in the E.E. department, Bell Laboratories employ more graduates of the University of Illinois than all the other E.E. schools put together, a truly complimentary testimonial for the electrical engineering department at the University of Illinois.

"My boy," said the businessman to his son, "there are two things that are vitally necessary if you are to succeed in business."

"What are they, dad?"

"Honesty and sagacity."

"Always—no matter what happens, no matter how adversely it may affect you—always keep your word once you have given it."

"And sagacity?"

"Never give your word."

* * *

"I don't think the man upstairs likes Johnny to play his drum."

"Why?"

"Well, this afternoon he gave Johnny a knife and asked him if he knew what was inside the drum."

● For many years K&E has pioneered in the manufacture and development of finest quality surveying instruments. K&E surveying instruments are renowned all over the world for their superb performance under conditions of all kinds, for their magnificent workmanship and for special features that come of progressive ingenuity.

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THE DU PONT DIGEST

Carl Gosline, *B.S., Iowa '41, conducts meteorological engineering studies to help solve plant chimney problems involving smoke and acids.*

Engineering Unlimited

Training in many different engineering branches opens the door to opportunity at Du Pont

In recent issues of the *Digest*, we have discussed opportunities for mechanical and chemical engineers at Du Pont. However, this is only part of the picture. The special skills of more than a dozen different branches of engineering are needed on our scientific teams. For example:

Architectural, civil and structural engineers are attached to the central Engineering Department which handles most of the Company's construction projects. In this work they make site investigations, lay out new plants, design buildings, determine construction methods and specify materials and equipment. They also assemble necessary labor forces at field locations and supervise the building and assembly of complex manufacturing facilities.

Electrical engineers aid in designing process equipment and facilities for power generation and distribution, air conditioning and refrigeration. Instrumentation is another important phase of their work. Continuous automatic analyzers for cyanides, ultra-violet gas analyzers, multivariable recorders, and new photo-multiplier circuits are just a few of their developments.

Industrial engineers help develop methods and standards for new or improved manufacturing processes. This work often serves as training for production supervisors.

Metallurgical engineers play an essential part in the central Engineering Department's program of research. Their studies are aimed at improving equipment and construction materials, as well as methods of measurement and control.

Safety engineers strive constantly to improve the broad safety program initiated by the Company's founder 150 years ago. Du Pont is understandably proud of its safety record, which in 1950 was eight times better than the chemical industry's as a whole, and fourteen times better than the average for all industry.

This by no means completes the list. Every U. S. industry utilizes Du Pont products. Hence there is also a need for specialists in mining, petroleum, textiles and many other branches of engineering.

Along with chemists, physicists and other technical personnel, almost every kind of engineer finds opportunity at Du Pont. Your engineering degree is only a door opener. Any man with ideas, imagination and the ability to handle people will find plenty of room for advancement in this company that has never stopped growing.

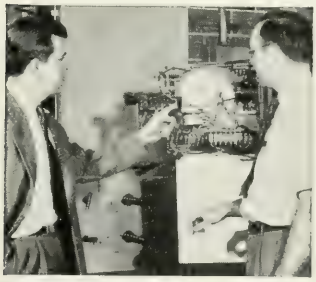
FOR HELP in choosing your career, send for free copy of "The Du Pont Company and the College Graduate." Describes futures for men and women with many types of training. Address: 2521 Nemours Bldg., Wilmington, Delaware.

DU PONT

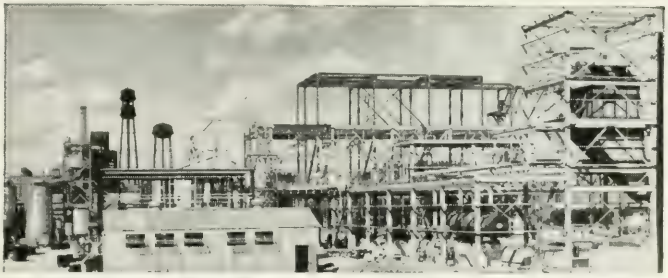
150th Anniversary

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Entertaining, Informative — Listen to "Cavalcade of America," Tuesday Nights, NBC Coast to Coast



Fred R. Struder, *B.Metal.E., Rensselaer P. I. '50, examines a pressure strain recorder with Allen R. Furbeck, E.E., Princeton '39.*



This Du Pont plant, *near Orange, Texas, manufactures nylon intermediates, plastics and heavy chemicals. Engineers attached to The Du Pont Company's central Engineering Department designed the plant and supervised the installation of the manufacturing equipment.*

INTRODUCING . . .

(continued from page 18)

engineering department's network analyzer.

Dr. Ryder was born in Columbus, Ohio, in 1907. He received his Bachelor's Degree in 1828 and again later, his Master's Degree from Ohio State university. Upon receiving his Master's he was employed by the General Electric company, where he specialized in electronic work and the development of thyrotrons under H. C. Steiner.

In 1931 Dr. Ryder joined the Bailey Meter company of Cleveland, as supervisor of the electronic section of the research laboratory. He holds 24 patents in this work, which consisted of temperature-recording and automatic control applications of electronics. The Bailey "Pyratron" group of devices and the General Electric and Weston photoelectric and potentiometer are now being manufactured under these patents.

Dr. Ryder furthered his graduate education by studying mathematics and atomic physics at the Case School of Applied Science while he was still at Bailey Meter.

In 1941, Dr. Ryder gained an assistant professorship of electrical engineering at Iowa State college. In 1944 he became professor of electrical engineering in charge of electronics courses and in the same year was awarded his Ph.D. degree in electrical engineering by the Iowa State college. From September 1944 to April 1946 he was temporarily professor in charge of the electrical engineering department.

DR. JOHN D. RYDER

In 1947 he became assistant director of the Iowa Engineering Experiment Station and continued in that capacity until the fall of 1949, when he was appointed head of the University of Illinois electrical department, the position vacated by Dean W. L. Everitt when he became dean of the college of engineering.

Dr. Ryder has written two textbooks, *Electronic Engineering Principles* (Prentice-Hall, Inc.) and *Networks, Lines and Fields* (Prentice-Hall, Inc.); these texts are currently being used in the courses EE 340 and EE 351, respectively. He has also authored various other authoritative papers on A.C. and D.C. motors, vacuum tube voltmeters, electronics and more recently, network analyzers.

An avid radio "ham," he operates his own station, W9UDE. Another interesting hobby which he has is color photography and he owns over 2,000 of his own Kodachrome photographs of western national parks. He also enjoys playing tennis when he can find the time.

Dr. Ryder is a member of many associations and organizations. He is a member of the American Association for the Advancement of Science, Director of the Institute of Radio Engineers and chairman of the committee of education for the same organization, and chairman of the electronics education subcommittee all of the American Institute of Electrical Engineers. Some of the honorary fraternities to which he belongs are Tau Beta Pi, Eta Kappa Nu, and Sigma Xi.

The work which Dr. Ryder and his department have set before themselves for the following year is that of the design and construction of an analog computor, which will solve differential equations. The network analyzer has been completed and its formal dedication has been scheduled for the 30th of April.

It can be seen from his educational background and practical experience that Dr. Ryder is exceptionally qualified for the work he is doing here. The combination of this educational experience and interest in activities exemplifies Dr. Ryder as one of the more distinguished personalities and educators on this campus.

"When I took the 'STADIUM ROUTE' bus to Urbana yesterday, Stalin sat next to me."

"You're crazy! The 'STADIUM' bus doesn't go to Urbana."

* * *

Canibal No. 1: "Am I late for chow?"

Canibal No. 2: "Yes, everybody's eaten."

AT JOINT Technical Meetings of Standard Oil Company and its subsidiaries, many opportunities are presented for an easy exchange of ideas. From formal meetings, where technical papers are read, to small discussion groups and conversations between individuals, a healthy and stimulating air prevails throughout the five-day meeting.

How Exchanging Ideas Advances Petroleum Progress

WHEN MORE than 150 scientists meet for five days and exchange views on their work during the past year, the American consumer is likely to benefit, through improvement of products for his use. Conversation between scientists can often accomplish a more complete and satisfactory coordination than mere exchange of written reports.

From May 5 through May 9 this year, the Standard Oil Company (Indiana) and affiliated companies held their tenth annual Joint Technical Meeting at French Lick, Indiana. The key scientists and engineers from the parent company and all its subsidiaries attended. More than eighty technical papers were presented.

In addition to the research men, the manufacturing, production, sales, chemical products, and patent departments of the companies were represented. This helped give a broad view of company problems.

The Standard Oil Joint Technical Meetings are outstanding in their field. The company has been a pioneer in bringing together scientists and engineers from all the branches of its activities.

This is another example of leadership in engineering and research, and well illustrates the progressive atmosphere men with technical training may find in a career at Standard Oil.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

Takes a lot to lay a carpet in the jungle

The scene is "darkest Africa".

But Africa is lightening. Man's quest for minerals, for new areas for agriculture and trade, is slashing ultra-modern, glaring-white air strips in once impenetrable jungle.

Those pavers, portable air compressors, pumps and air tools—such as you might see working a city street—are Worthington Blue Brutes going to "lay a carpet" in that hole in the jungle.

Thus, Worthington, a major producer of equipment for public works, industry and farm, brings the fruits of American technical genius to the strange places of the world.

And illustrates, too, how the unique American talent of *diversification* helps public, employees and stockholders. For Worthington makes many things—not just construction equipment and pumps, but also engines, water works machinery, power transmission, petroleum equipment, air conditioning and refrigeration, many others.

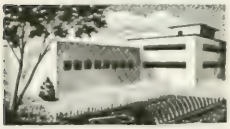
Such diversification builds *stability* . . . makes Worthington, 112 years old, a strong link in the chain of American business.

Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Harrison, New Jersey.

WORTHINGTON

The Sign of Value
Around the World

1.14



Good Water and Sanitation—engines · pumps · water treatment · comminutors · air compressors · air tools

Lower-Cost Manufacturing—pumps · compressors · steam turbines · motors · power transmission · air conditioning

Petroleum Products—compressors · engines · pumps · chilling equipment · refrigeration · decoking systems

More Abundant Food—compressors · fertilizer mixers · air conditioning · refrigeration · pumps

"Find Yourself"

. . . without losing time!

by FLOYD O. SMELTZ, *Supervisor, Standardization Section*
WEST ALLIS WORKS (*Graduate Training Course 1950*) *Ohio State—LE—1949*

FLOYD O. SMELTZ

SELECTING a specific job in the engineering field after graduation from college is a tough proposition for most of us. It was for me, and that's why I came to Allis-Chalmers. I thought I wanted to be a development engineer but I wasn't sure. Allis-Chalmers Graduate Training Course gave me an opportunity of trying design and development—and other types of work also. By my own choosing I am now engaged in challenging work which I hadn't even considered while in school. The point is, all GTC's have the same chance of "finding themselves."

Allis-Chalmers car shaker empties coal and ore cars in minutes. Saves time . . . prevents injuries by keeping men out of car interiors.

That's the outstanding feature of Allis-Chalmers Graduate Training Course. You have a very broad selection, and you yourself choose the type of training you receive. Of course you get help and guidance from experienced men throughout your training period. You need it, since there are jobs here that you have never dreamed of.

Finds Job Challenging

Take my job for instance. To the engineering student it probably sounds rather dull when compared with Advanced Thermodynamics or Electric Transients in Power Systems. But, in my opinion, the most fascinating science is coordinating engineering and production efforts through standardization of procedures, parts and materials. As Supervisor of the Standardization Section and Chairman of the Standards Committee, I encounter new problems every day—no monotony here.

But that is only part of the story! I am also Secretary of the Chief Engineers' Committee and Secretary of the Development and New Products Committee. What could be more stimulating for a young engineer than to be at the crossroads, where he can watch the engineering planning of an expanding company?

No Limit to Opportunities

I never thought I'd be doing this when I graduated from Ohio State in 1949 and enrolled in Allis-Chalmers Graduate Training Course. As I mentioned, I was particularly interested in design work at that time. In fact, right now there is a patent applied for on an electro-magnetic relay device I designed. Yes, they even let me do development work while still a GTC student.

A student helps plan his own courses and is free to change his plans as new interests, new opportunities present themselves. He can divide his time between shops and offices—switch to design, manufacturing, research, application engineering, sales, or advertising—and can earn advanced degrees in engineering at the same time.

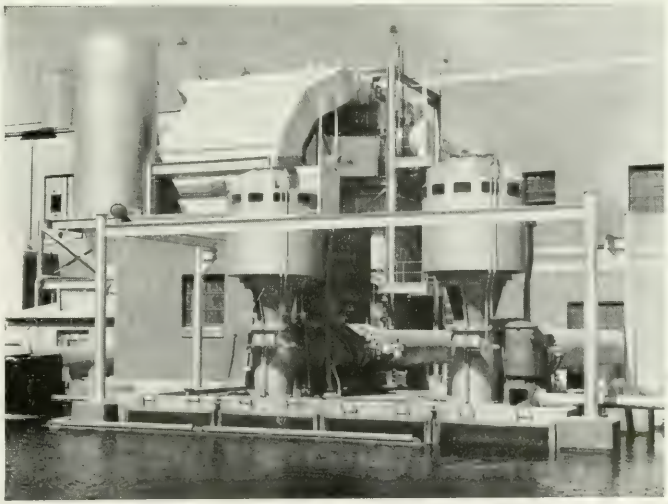
When he graduates from the course he is encouraged to go into the type of work he liked best while on the Graduate Training Course.

One of the reasons Allis-Chalmers offers so many opportunities is that A-C designs and builds machines for every basic industry, such as: steam and hydraulic turbine generators, transformers, pumps, motors, rotary kilns, crushers, grinders, coolers, screens, and other machinery for mining, ore processing, cement, and rock processing. Then there are flour milling, electronic equipment and many others.

There is no other organization that seems to me to offer the graduate engineer such a wide range of activities, or that gives him such a chance to find the type of work for which he is best fitted.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin



Weatherproof motors for condenser cooling water circulating pumps were mounted outdoors to conserve valuable building space for a Texas utility.

The Magic Slide Rule

by Lee Grossman, m.e. '53

Not too long ago when all the world was plunged into the scent to approach, just after Copernicus was hanged by his heels because he declared his belief that the sun was the center of the solar system, and proved it by that method which we accept and even glorify, there lived a little man in the town of Sorento where all the little glass figures of women come from.

This little man was not interested in little glass figures. Rather, he had an all consuming interest in an invention which he called his slideth stick. It was a queer gadget and people came from all around to see it operate. When they saw it they laughed and cried, "Torcelloni has gone mad. See how he moves that stick. Who would spend all his time with a little wooden stick when he could be making little glass figures like his father."

Torcelloni would remain calm at these outbursts. He would just smile and slide his slideth stick back and forth, reading figures all the time. If anyone would be interested enough to ask a question, Torcelloni would sit them down and talk for hours about the wonders of his slideth stick. Then they would nod their head "yes" and walk away scratching their heads.

This went on for several months. People would come to see the crazy man of Sorento slide pieces of wood between his fingers. "That's not the way to make fire they laughed." One fellow even tried to burn his wooden stick and Torcelloni along with it: Torcelloni remained unmoved.

Now it so happened that at the University of Florence there lived a professor who was known for his theories on mathematics. Torcelloni decided to take his slideth stick to this man and let him decide its worth. Torcelloni got on his mule and rode for two days and two nights until he finally arrived at the gates of Florence. Then he saw the professor and showed him the stick with which he could do mathematical problems that would take the ordinary mathematician hours to do. The professor, a very learned man, was amazed at the slideth stick. He had never in his life seen the equal of this stick. Here was a stick that was truly magic.

The professor praised Torcelloni for his genius and asked him all sorts of questions about the slideth stick. They talked for hours and finally the professor said, "Come, my friend. You must be hungry. Let us eat." They put the slide rule down near the fire while they went to supper.

The fire was blazing because it was cold outside. All the good housekeepers of Florence keep a blazing fire going when it is cold outside. One of the sparks from the fire happened to strike the cushions of the chair where Torcelloni placed his slide rule. In less time than it takes to tell, the chair and the slide rule were burned to a crisp, and the room itself was all in flames. The professor and Torcelloni jumped up and rushed to the fire house in the town square. All the townspeople came to help put out the fire for they dearly loved the professor for he was known for his acts of kindness.

Soon the fire was put out and the damage surveyed. The house wasn't badly burned, but all that remained of the cushioned chair and the slideth stick was a pile of ashes and a bit of horse hair. Torcelloni began to weep for the loss of his slideth stick. The Professor, who loved his cushioned chair felt very badly too, but he consoled his friend. "Now now. We can build another one even better than the first one." But Torcelloni couldn't be consoled. The very next day he set out for Sorento.

The kindly professor, whom everybody loved, never tried to duplicate the slideth stick, although many times he was tempted to try. As for Torcelloni, he too forgot his slideth stick and turned to making little glass figures. Perhaps this was best, for Torcelloni couldn't duplicate his slideth stick even if he tried. In those days, before the era of scientific approach, the people believed in magic. Torcelloni too believed in magic, and he believed that Torres, god of reasoning, had charmed his slideth stick. Now it could never be charmed again, for Torcelloni no longer believed in magic. His slideth stick taught him to believe in science.

Should Torcelloni have been less the scientist and more the fool, the world today might have benefitted, for this magic slideth stick was nothing more than our everyday slide rule with one exception: Torcelloni's slideth stick placed the decimal point.

SKIMMING . . .

(*continued from page 42*)

the research laboratories of the American Petroleum Institute, a service organization for the entire industry. In addition, many graduate and undergraduate chemical and chemical engineering labs are involved in delicate measuring projects. Westinghouse Sturtevant fans, air-conditioning, and heating units play an indispensable role in the maintenance of required atmospheric conditions and removal of undesirable fumes in the labs.

In one section, the purity of a hydrocarbon is checked by measuring its freezing point. By use of the platinum resistance thermometer and an extremely accurate resistance bridge, they will be able to obtain an accuracy within 0.002°C in freezing point comparisons. Of course, it is imperative that the atmospheric conditions here remain constant, and in the required state. Here, as well as in other sections where temperature measurements as accurate as 0.001° C are made, precise control must be maintained.

unique dry-process copying technique

A new, rapid, and exclusive dry-process method for making exact and permanent copies of all types of written or printed material has been announced by Minnesota Mining Co. Called "Thermo-Fax," the "method" employs a new duplicating machine and heat-sensitive paper.

An infra-red light is sent through the heat-sensitive sheet to the original. The rays, striking the black type face, are converted into heat which reproduces the original on the sheet.

This new process requires no negatives, chemicals, washing, or drying. The permanent copies, produced in 15 seconds, ready to distribute, do not fade or change color.

The sheets used in this process are not sensitive to light and may be stored in any convenient area. No proof reading is necessary and copies of secret documents may be made by officials without assistance.

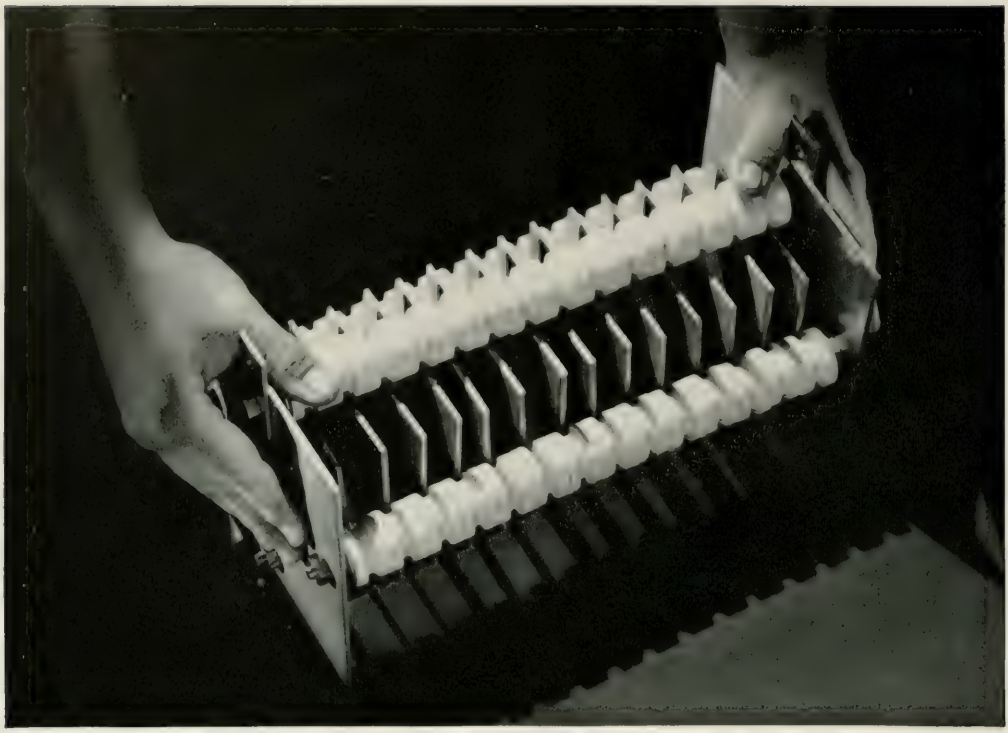
Back in 1921, an engineer's definition of a slide rule went like this:

"A slide rule is something like a woman. It is slippery and no one ever learns to manage one. It has a variety of figures which are more or less true. Men are crazy until they get one and after they get it, they wish that they had saved their money. But, unlike a woman, a slide rule can be put in a leather case and shut up."

illinois technograph

.25

october, 1952



Steel guinea pig about to have a breakdown

● We've come a long way toward licking the No. 1 enemy of steel—*corrosion.*

At United States Steel, for example, we've learned a lot through exposure tests, equipment service trials, accelerated laboratory tests, and the like. But there's just one way to be sure which grade of steel will give the longest service per dollar of cost on any given job: *try it under actual operating conditions.*

That's where the steel "guinea pigs" come in. Those expendable corrosion test racks are made up from a dozen or more different grades of steel separated by porcelain insulators that prevent galvanic action. We actually put the "guinea pigs" right into the operating equipment that contains corrosive liquids or gases. Then, when the steel specimens have been exposed to the service conditions for predetermined periods of time, we remove the guinea pigs, send them to the laboratory and determine the most economical steel for that particular service. To our way of thinking, this is the most accurate way to decide what grade of steel is the best buy for a particular installation.

Actual on-the-job corrosion tests like these have saved many thousands of dollars for refineries, textile and paper mills, food processing plants and other manufacturers to whom corrosion is an expensive headache. For these users, the cost of steel replacement has been lowered; and our customers have had fewer hours of lost production time due to corrosive failure.

This guinea pig test is typical of the many and varied research projects sponsored by United States Steel. Trained metallurgists in the field and in dozens of research laboratories are working to develop new steel compositions, and to solve problems involving the more efficient use of steel. United States Steel Company, 525 William Penn Place, Pittsburgh 30, Pa.

USS

UNITED STATES STEEL

Easy way to get rich

SUPPOSE, as you enter a grocery store, you suddenly find the denomination of every bill in your pocket has doubled! You're rich! Until you find that the same "magic" has doubled the price of everything in the store.

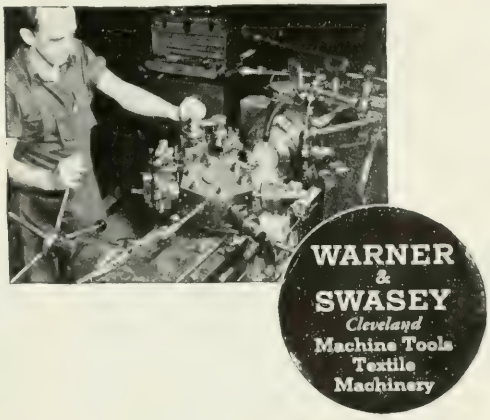
That's the sort of "prosperity" America has been "enjoying."

Most Americans feel they're worth more today than a few years ago; actually their savings have been whittled away 23% in the 7 years since the war. *More money without more goods* always bids prices up and up to the sky.

If you like what's been happening to you, if you think this is prosperity, let's make a *good* job of it; let's make every bill a *million* dollar bill—or a *billion,* as Germany did. If inflated money makes everybody happy, let's be hysterical!

But Germany didn't find it much fun, the morning after.

Source: "How to Keep Our Liberty" by Raymond Moley. Published by Knopf, 1952



YOU CAN MACHINE IT BETTER, FASTER, FOR LESS WITH WARNER & SWASEY TURRET LATHES, AUTOMATICS AND TAPPING MACHINES

8 ways up with Phillips Petroleum Company

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Scientific and technical graduates looking for a "career with a future" will find that Phillips offers many and varied opportunities for qualified men.

Petroleum is a young and progressive industry—and Phillips is a young and progressive company. In addition to our production of motor fuels and lubricants, Phillips is an important manufacturer of such diversified products as carbon black, chemical fertilizers, synthetic rubber, and many other compounds derived from petroleum hydrocarbons.

In most phases of the company's operations we offer supervised on-the-job training for new men to prepare them for assignments of responsibility and importance.

We invite qualified men to write to our Employee Relations Department for further information about opportunities with our company.

Phillips 66

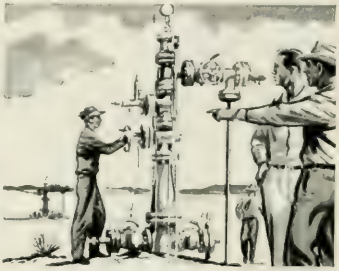
PHILLIPS PETROLEUM COMPANY

Bartlesville, Oklahoma

OIL PRODUCTION DEPARTMENT drills wells and produces crude oil. It is also the responsibility of this department to unitize oil fields for highest economic recovery.

REFINING DEPARTMENT converts crude oil to finished marketable products. Utilizes advanced technology for maximum upgrading of raw petroleum.

NATURAL GASOLINE DEPARTMENT extracts light hydrocarbons from natural gas. Phillips is the world's largest producer of natural gas.



NATURAL GAS DEPARTMENT produces, gathers and sells natural gas in the development of one of the world's largest gas reserves.

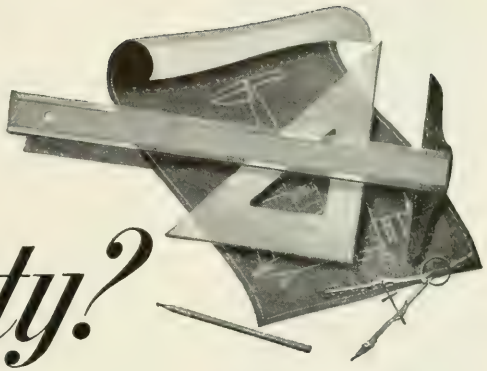
SUPPLY AND TRANSPORTATION DEPARTMENT operates pipe lines, tank cars, barges and motor vehicles . . . purchases, sells and gathers crude oil.

PHILLIPS CHEMICAL COMPANY is a leader in fast-developing field of petrochemistry . . . manufactures and sells nitrogen fertilizers, carbon black, monomers and high polymers.

ENGINEERING DEPARTMENT designs, constructs and inspects new facilities, tests materials and operates the company's communication systems.

RESEARCH AND DEVELOPMENT DEPARTMENT conducts research, pilot plant and semi-commercial development, procures patents and surveys markets for new products.

Where will you find *A Broader Opportunity?*



IF you are looking for one of the better jobs in engineering, you certainly will want one that offers the widest scope for your talents. You will find it at Goodyear Aircraft—America's only producer of both heavier- and lighter-than-air craft, along with a wide range of aviation equipment.

You can measure your opportunity by facts like these:

Goodyear has been a pioneer in many of these fields for more than forty years.

Goodyear introduced the first airplane tire in 1910, as well as many of the landing gear improvements in use today, including Single and Multiple Disc Brakes and Cross-Wind Landing Wheels.

Goodyear was the first American manufacturer to employ Duralumin in the construction of aircraft and developed many of the processes now used in shaping and forming metal structures.

Goodyear Aircraft Corporation today is producing airships as well as numerous components for many other aircraft, including electronic and radar devices.

Thus whatever your field of engineering, you will find an opportunity for advancement at Goodyear—in one of America's largest companies that has been expanding steadily through peace and war since the earliest days of aviation and will continue to do so.

Why not investigate today?

LOOK NOW

at the opportunities for you in research, design, development and production of:

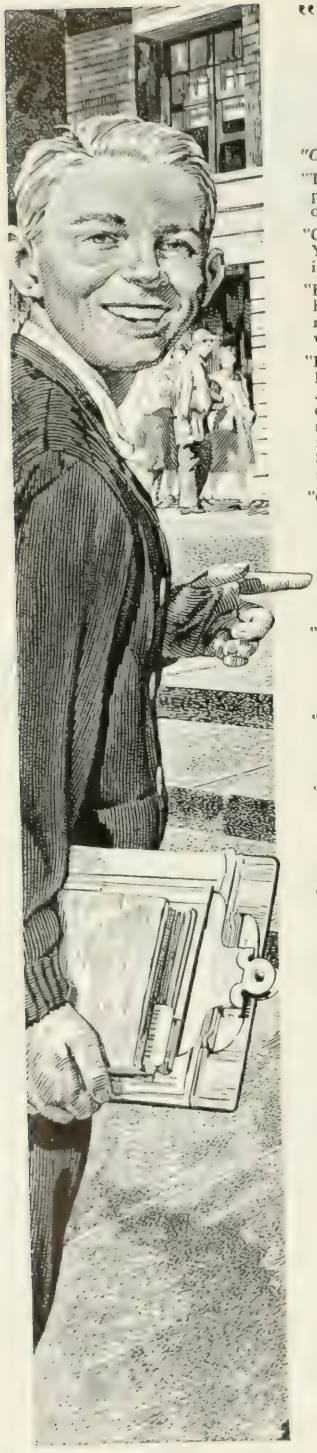
AIRPLANES ★ AIRSHIPS ★ HELICOPTERS ★ GUIDED MISSILES ★ AIRCRAFT COMPONENTS ★ ELECTRONIC COMPUTERS ★ GUIDANCE SYSTEMS ★ TRANSPARENT ENCLOSURES ★ REINFORCED PLASTICS ★ RADOMES ★ BONDED SANDWICH STRUCTURES ★ WHEELS AND BRAKES ★ RADAR STRUCTURES and many others.

★ ★ ★

Submit a brief resumé of your experience and qualifications, or write us for an application blank and further information.

Prompt consideration is assured. Address Salary Personnel Department, Goodyear Aircraft Corporation, Akron 15, Ohio.

GOODYEAR AIRCRAFT



"Willie wants to be President!

"Of our Student Council, that is.

"That's him over there, passing out his campaign handbills like an alderman passing out cigars.

"Our school elections used to be pretty dull. You know, a couple of funny posters put up in the halls, and that was about it.

"But our new Civics teacher, Mr. Leszczynski, has a theory that we'll learn a heck of a lot more about government and Americanism if we have less reading and more *doing*.

"He started out last year by making two school Parties . . . conventions, platforms and all that. And, while we had a lot of fun with our elections, we learned a lot about government at the same time. We've even got a regular Congress . . . with teachers in our Senate and us pupils in our House of Representatives. All elected by us, too.

"One of the things Mr. Leszczynski keeps drumming into us is the Bill of Rights of the Constitution. He's pretty hot on the subject of our Freedoms . . . religion, press, speech and the rest. He practically *begs* us to appreciate those Freedoms *every* day of our lives, not just on the Fourth of July and on Thanksgiving Day.

"He's not so dumb, either. He must've figured we'd sort of take our lessons home and pass them along to our families. 'Cause since he came to our school, our Parent-Teacher's meetings have been standing-room-only.

"And last regular Election Day in town, more'n 80% of our parents voted. I know both of mine did . . . and so did my big brothers and sisters.

"The funny part about it is . . . *Mr. Leszczynski wasn't even born an American!* But he never misses a chance to vote or take an active part in civic affairs. And he keeps reminding us he had to come to *this* country to find out what Freedom really means.

"To show you what us kids think about him . . . he's the *only* teacher we don't have a nickname for behind his back."

REPUBLIC STEEL

Republic Building • Cleveland 1, Ohio

REPUBLIC STEEL

Republic BECAME strong in a strong and free America. Republic can REMAIN strong only in an America that remains strong and free . . . an America whose people enjoy the many fine products of a modern Beverage Industry. *And, through the Beverage Industry, Republic serves America.* Many, many tons of its carbon, alloy, and, especially, stainless steels are formed into vats, tanks, mixers, bottling machines, vending machines, cans, shipping containers and dispensing equipment. Steel equipment like this makes it possible for Americans to enjoy their favorite tasty and refreshing beverages the year 'round.

* * *

For a full color reprint of this advertisement, write Dept. H, Republic Steel, Cleveland 1, Ohio.

An Editorial . . .

With the beginning of the new academic year the line of demarcation between activities and studies must be redetermined by all of us, in order that we may maximize the benefits that may be derived from our educational opportunities.

To strike a favorable balance between studies and activities has long been a difficult task, for if one is over-emphasized in lieu of the other our education will be deficient in important elements. President Stoddard has said that only fifty percent of our education is derived from classroom work. This clearly indicates the value of our associations, through activities and living groups, in obtaining a fully rounded education.

One of our primary goals during our college career should be the acquisition of the ability to work and live happily with our fellow men. This trait, and the sense of responsibility to others that accompanies it, can be obtained from extra-curricular activity. Since the demand of classroom work is a constant force acting upon us, and therefore is more easily regulated than the vague impetus provided by activity opportunities, we are perhaps more troubled by the problem of determining just how much time can be devoted to extra-curricular activity.

Within the extra-curricular field there is no external compulsive force to drive the student. Here the dividend returned is commensurate to the talent and energy invested. The benefits from this employment are compounded, however, when coupled with academic attainment. Together they provide a full and invaluable basis for good citizenship and help to assure economic security through gainful employment. Each of us must determine to what degree he may digress from the academic pattern in order to embrace the advantages that may be derived from extra-curricular endeavors. No one can determine for us to what extent these activities will prove helpful, nor can anyone form the value judgment for us which must stimulate the interest in activities. Yet, let each of us acknowledge the worth of participation and the degree will be determined by our own initiative.

Now is the time to recognize the need for the other fifty percent of our education. Though it may appear overly zealous or, possibly, erroneous to ascribe such import to non-academic endeavors, it is difficult, if not impossible, to determine correctly the point of division in the "twilight zone" between academic activity and non-academic "activities." From both may be derived knowledge which is essential to the fully educated man. Tomorrow, a half-educated man may find the barrier to success, imposed by neglect in either area, too formidable to surmount.

AOV

Brush Up on Cellulose Gum

PROBLEM . . .

. . . to discover a domestic material for blending the many ingredients of modern-day toothpastes, shampoos, lotions, and other cosmetic preparations.

SOLUTION . . .

. . . cellulose gum—pioneered by Hercules. Added in very small quantities by manufacturers to their formulations, cellulose gum simplifies production.

COLLEGE MEN . . .

This is but one example of the far-reaching chemical developments in which you could participate at Hercules—in research, production, sales, or staff operations. It suggests the ways Hercules' products serve an ever-broadening range of industries and end-uses.

Hercules' business is solving problems by chemistry for industry . . .

. . . detergents, rubber, insecticides, adhesives, plastics, paint, varnish, lacquer, textiles, paper, soaps, to name a few, use Hercules® synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products and other chemical processing materials. Hercules® explosives serve mining, quarrying, construction, seismograph projects everywhere.

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the illinois technograph

volume 68 number 1

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our cover

The civil engineers we feature in this issue are helping to provide America's needs in transportation, structures and mapping. The cover illustrates a plane table man engaged in topographic mapping in Idaho. Before any large scale civil engineering project can be undertaken, explorations relative to determining sufrace and subsurface conditions must be made. The civil engineer is well versed in this art and has adapted many inventions from other engineering fields to facilitate his investigations. (Courtesy Standard Oil of New Jersey.)

our frontispiece

The aerial photograph shows the Champaign-Urbana area. Photographs such as these are invaluable when planning townsites; locations of highways, railroads, or pipelines but their chief use is in mapping as described in the article on photogrammetry in this issue. An area that would require five years to map by grounds methods can be mapped in ninety days with the airplane. An old art, civil engineering nevertheless has utilized many of the latest scientific developments to further its work. (Courtesy of U. of I. Surveying Department.)

precision mapping with . . .

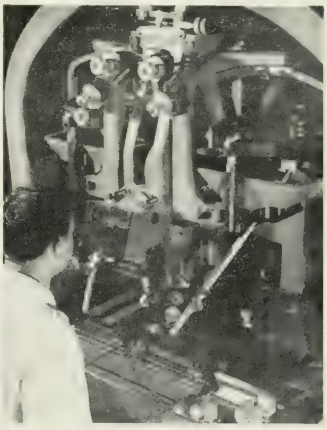
Aerial Photogrammetry

by Tom Madden, M.E. '54

Photo reconnaissance at a few cents an acre—topographic maps at half the cost of ground surveys—these are the air survey economics that put up-to-date mapping coverage within many industries' budget. Unlike ground surveys, aerial mapping is flexible. The same set of aerial negatives will do three jobs. First, you get aerial photos for stereoscopic study. They can be assembled into a photo-mosaic—a good reconnaissance map. Then, with the areas of interest defined, a contour map can be compiled from this same aerial photographic base. Each of these products of the aerial survey can be used in money-saving ways.

To the mining engineer aerial photogrammetry is a great help. First the aerial mapper delivers individual aerial photographs to the mining engineer. These are taken with an overlap of 50 to 60%, so that pairs of photos may be studied stereoscopically. Seen in this third dimensional view the relief is great, and details that often go unseen on the ground may be observed. For example, the geology of an area can be studied. Such geologic features as benching and outcrop may be traced, though in observation on the ground they are often obscured by brush. This stereoviewing will never take the place of first-hand observation and study of surface geology, but it does supplement it importantly. It helps to direct ground studies to areas of primary interest. During the weeks when weather makes ground studies virtually impossible, stereo pairs of aerial photographs are useful in scanning the area and making plans for later field work. Timber for mine use is a problem always with the engineer, and here the aerial pictures can help in an evaluation of timber resources. With the stereoscope the engineer can identify timber types and estimate size.

Assembled as a precise photo-mosaic (photo-map) these aerial photographs provide a broad overall view of the entire property. Why undertake ground reconnaissance, says the progressive engineer, when you can buy an aerial photograph record of the whole property for less per acre than the cost of driving over it? Although not quite as accurate as the topographic map, the photo-map records a wealth of cultural detail in true relative scale. It can be the base for planning redevelopment—for forestation or reclamation of mined-out areas. In those states requiring that a bond be posted and a map submitted before an area is worked, the photo-mosaic satisfies the map requirement at minimum cost.



The stereoplotter and computer traces contours from stereoscopic pairs of aerial photographs.

Deriving Topographic Maps

With the photo-map at hand, the areas of interest can be defined for detailed topographic mapping. The topographic map is the most exact product of aerial mapping. It is compiled in one-half to one-fifth the time needed for ground surveys. Its costs are very much less than with plane-table methods, and its accuracy equals or exceeds maps prepared by ground methods. Aerial photography captures a great deal of the cultural information not ordinarily shown on maps because of the prohibitive cost of securing such detail. However, this detail is easily traced from the photographs and shown on aerial topographic maps. With an aerial topographic map the mining engineer can:

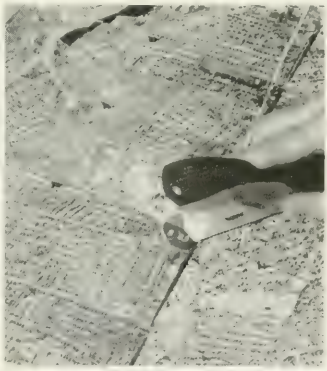
1. Estimate coal acreage.
2. Delineate crop lines.
3. Plot boreholes.
4. Lay out access roads.
5. Locate spoil dumps.
6. Plan rail spurs.
7. Compute overburden.
8. Plot workings for tax purposes.
9. Plot property lines.

The map's usefulness develops and grows within the mining company. A number of companies have found that after the maps are at hand scarcely a week passes that an office solution is not found for problems which before could be solved only by sending men into the field. The saving in time, plus the saving in the cost of the field parties, is substantial. The needed map facts are there—detailed, accurate, up-to-date and readily at hand for management decisions. They speed the solution of many an operating problem, from rapid quantative estimates of acreage and overburden to broad redevelopment planning.

Costs

The price tag for the air survey varies according to the size and shape of the area, scale of the maps, amount of existing control and the contour interval. But for areas of 1,000 acres or larger, the air method always costs much less than ground surveys. For instance, aerial mapping of a 7,210 acre prop-

(*Continued on page 26*)



All photographs are mounted on a board so as to be identified by their index numbers.

WANTED . . .

Civil Engineers

by Warren H. Brandt, C.E. '54

Wanted . . . wanted . . . civil engineers . . . Frisco Railroad . . . wanted . . . civil engineers . . . Department of Highways . . . Rock Island Railroad . . Department of Subways and Superhighways . . . and so they read, advertisments, literally hundreds of them, and they want you. You, the civil engineering student, are a most sought after person. And according to a recent release by the U. S. Department of Labor you will be in demand for some time.

What are you going to do when you graduate? Well, depending on the course of study, you selected during your last year in college you can enter into numerous branches of the civil engineering art. There is the structural field, the highway and railroad branch, the construction end and the hydraulics department.

Just what does a civil engineer do on these jobs? Take a state highway department for example. The young civil engineer will often take his first job in the field, out where the breezes blow. He will in all probability be a rodman or a chainman on a survey party. Many of the chief highway engineers of the forty-eight states started out in this manner. The survey party is a broadening experience for any civil and most of the men seem to relish that type of work. The survey party is a forerunner of bigger things to come. They operate in advance of the construction crews. The data for plotting details of the highway location and grade are secured by this group. The young engineer is taught the necessity of securing accurate field data when he comes into the office to plot the party's notes. The new man often spends considerable time plotting the alignment and grades for new highway projects and, if he is lucky, he may be assigned to the construction department in the spring.

Civil engineer in a construction crew usually finds himself a pretty busy man. The various machine operators seem to thrive on knocking out his carefully set line and grade stakes. He has set stakes all over the country, at the bottom of fills and at the top of a cut and sometimes he wishes that he was in a different business. But after the highway starts to take shape his handiwork and care are very evident. Then the contractor starts to pour the highway slabs. Here is where many a civil engineer becomes a sort of "watch-dog" for he serves as an inspector on a paving job. The civil here is rather wary and cautious to see that every item written into the specifications is included in the job. Quite a task but also quite rewarding when one considers that in many cases right here is where the taxpayers pocketbook is protected.

Suppose the civil engineer was, on the other side of the fence, working for the contractor. He would rub shoulders with the State's engineer and would probably take him out to dinner, on the job, however, all fraternization ceases, for the contractor's engineer is only concerned with the orderly operation of the construction equipment. He sees that the right machine is in the right place at the right time. He may even be a superintendent. If so, he really has plenty to occupy his time. He is also cooperative with his superior in the person of the State's engineer for he knows that both of them want to get a job done in the most efficient manner, although the contractor may think sometimes that the specs were written by a grade school child. Nevertheless, with their shoulders to the wheel, these engineers get the job done. The thousands of miles of highways in this country will attest to this fact.

Back in the office again, we meet the civil who writes the specifications the field men must try to interpret. Here is applied engineering at its fullest. The experience possessed by many a specifications writer is only available through contact with the work, and a good one is usually worth his weight in theodolites. He knows the current status of Workmen's Compensation Laws in the state of New Hampshire. He can give you the latest ASTM specification for a cut-back asphalt. He knows the type of filler required at each pavement joint. In short he is a walking encyclopedia.

Over there is another civil, he seems to be doing a lot of figuring. No calculus here, just plain arithmetic, considerably refined of course. Why he's estimating the amount of steel and concrete required for a new bridge on our tentative highway. He doesn't have to be a 'whip' at numbers, but he does have to be thorough. Every item must be enumerated on his sheets and tabulated in the summary of costs. His is a time-consuming job, but highly important. He will give you the price on that tablet they place on the end railing of a bridge and he can tell you just how much concrete will be required for the abutments of that bridge.

The structural engineer has just finished computing the stresses for the new suspension span required over a deep valley. He looks back on his college days when stresses, tensions, influence lines, and moving loads seemed to be just headaches for him, but now he is applying the many lessons he had to learn and he is glad that he learned them well. The safety of the traveling public is dependent on his judgement.

The responsibility with which a structural engineer is entrusted corresponds favorably, in the eyes of many, with that of a physician. The judicious use of materials with a conservatism oft condemned by the architect has placed the structural man in a high professional standing.

While we're talking about the structural engineer let's mention his work in the building field. Someone said that "if an architect built a building without the help of an engineer, it would fall down; but if an engineer built a building without the help of an architect, they'd tear it down." Be that as it may, the engineer designs those structures soundly, often with a great toil when the architect has come up with some "functional" design that seems to be suspended from sky hooks. The structural engineer has made use of the most modern construction materials, and the use of pre-stressed concrete has attracted the eye of many of them. It is not too far-fetched to believe that our colleges will shortly be offering courses in this new construction medium and the public can look for an expanded program utilizing this somewhat phenomenal idea.

Structural engineers then, have catered to the whims of almost every other branch of engineering. They have had to dodge their columns and beams around the pipes of the mechanical and chemical engineer. The engineering physicist wants walls eight feet thick so that the betas from his betatron won't be beta-ing people into oblivion. Even the electrical engineer wants an extra heavy floor for his transformers and generators. The structural man will accomodate all of them and will do it safely with a minimum of cost.

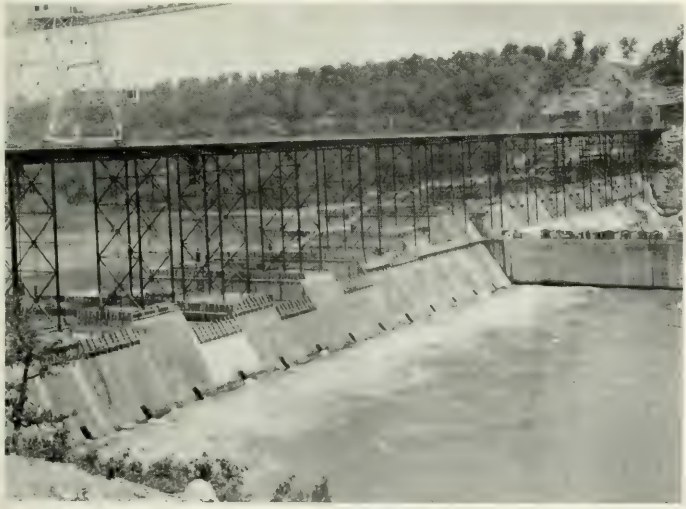
Latest civil engineering research product is the continuous welded rail, providing a smoother riding surface, resulting in greater comfort for the passengers and less wear on the roadbed and equipment. (Courtesy C. & N. W. Ry. NEWSLINER magazine.)

Many civil engineers have found employment with firms interested in hydraulics. The government through the Corps of Engineers and the Bureau of Reclamation has greatly expanded its hydraulics department in recent years to embrace the new flood control and reclamation projects. Stream studies and dam construction occupies most of the time of this young engineer, and water flow is right up his alley. The outfall from the penstocks of a great power dam is in his realm and he is very much concerned with any problems dealing with fluids.

Consulting engineers have taken great numbers of civils into their ranks. The opportunities with firms of this type should not be neglected. They are often highly specialized and the civil is enabled to practice his art with considerable authority. The work varies and one day the engineer may be designing a water treatment plant for the city of Monrovia, Liberia and the next day he may be working on the design for a superhighway into Caracas, Venezula. Different firms handle different phases of engineering such as a firm specializing in municipal works or in superhighway projects. Civil engineers interested in travel and work in the full range of civil engineering subjects should investigate these employment possibilities.

Work with the government agencies has been mentioned casually. The civil has found himself in many unusual positions and places when working with the government. The work of the Corps of Engineers in river and harbor improvements is well known. The work of the survey agencies such as the United States Coast and Geodetic Survey, the Geological Survey, the Forest Service,

(*Continued on page 28*)



The several branches of civil engineering—structural, hydraulic, topographic and construction—are required in the construction of a project such as Bull Shoals Dam. The structure over the dam is a temporary construction trestle.

the Technograph features the . . .

Civil Engineering Department

by Ray F. Wojcieszak, C.E. '53

In 1867, the University of Illinois began, and with it originated the civil engineering department. It was not until 1869 that this department had its first professor and a few instructors. From that small beginning the department has grown steadily until now it is one of the biggest civil engineering departments in the country. Of all the Bachelor of Science degrees, Master of Science degrees, and Doctor of Science degrees in civil engineering awarded throughout the country, the University of Illinois awards 1/50, 1/10, and ¼ of the respective degrees. This is indeed a remarkable record and one of which the Civil Engineering Department is justly proud.

At present the civil engineering department is under the capable guidance of Professor W. C. Huntington. Along with Professor Huntington there are thirty-one professors and seven instructors who comprise the teaching staff. There are also many lecturers and research men that are part of the department. In this department the general rule is to keep the classes small, thus enabling each instructor to know his students individually. To facilitate this, each instructor has office hours during the week to allow the student to obtain extra assistance.

There are probably many questions about the civil engineering curriculum and its purposes. The first question that probably comes to mind is, "what is the curriculum supposed to do for the student?" In a University of Illinois bulletin I found an answer which reads, "While the instruction aims to be practical by giving the student information and practice directly applicable to his future professional work, the object is the development of mental faculties. The power to acquire information and the ability to use it, is held to be of far greater value than any amount of so-called practical acquirements."

In the first year of school all engineering students take the same courses. 1st semester courses are, chemistry, general engineering drawing, college algebra, trigonometry, rhetoric, engineering lectures, physical education, and military.

Courses for the 2nd semester, are, chemistry of metallic elements, descriptive geometry, analytic geometry, rheoteric, hygiene, physical education, and military.

Many students will argue that taking certain of these courses is a waste of time. Descriptive geometry, and analytic geometry are particularly condemned. It must be emphasized, however, that these courses are utmost importance. Descriptive geometry is an engineering drawing course where the student is taught to solve engineering problems graphically. It is designed to make the students think. Analytic geometry is the mathematics of straight lines and curves encountered in plain and solid geometry and is a stepping stone to the calculus.

Between the first and second years, during the summer session, the student in civil engineering encounters his first C.E. courses. The first course is C.E. 101, surveying theory. In this course taught during the first three weeks of the summer session, the student becomes acquainted with surveying instruments, some of their uses, and computation pertaining to surveying. C.E. 102 (surveying practice) is given in summer camp which is of five weeks duration. The summer camp is located in northern Minnesota and actual field conditions prevail.

The second year finds the student taking the following courses; *1st semester*: route surveying (C.E. 103), building construction (C.E. 160), calculus, physics, physical education, and military; *2nd semester*: economics or speech, geology, calculus, physics, analytical mechanics (statics), physical education. and military. Courses that may need some elaboration are: route surveying, building construction, geology and analytical mechanics. Route surveying concerns the economical planning of transportation routes. This takes in the surveying aspect and the computations encountered in the construction of transportation routes. Building construction acquaints the student with the different types of building materials, and their proper uses. Geology gives the student his first contact with soil and rock problems.

(*Continued on page 36*)

Engineering Hall: home of the Civil engineering department

A Message from Your Dean

One of the duties of a dean which is so much of a pleasure that it should not be called a duty is to say Welcome to our new students. It's a pleasure for many reasons.

One is that we always like to see the Illini family grow. We know that the University and its College of Engineering give a fine education—and we are glad to see the number of men and women who avail themselves of its opportunities.

A second reason is that good teachers want the stimulation that comes from new students. Each one of you is different from anyone else who has ever attended this University. Each one of you has his own approach to scientific and engineering problems, his own reactions to the many ways of teaching and learning, his own approach to daily living. Those approaches stimulate us. They help to keep our methods and our views from becoming stodgy or automatic.

Having you with us is a pleasure for still another reason. Many of you and many of us will go beyond the student-teacher relationship and will become personal friends. We will keep in touch with one another for many years to come.

So we are glad you are here. We know you feel the same. We know all of us will benefit from your being here.

But none of the benefits will just happen. We have to attain them. On your part and on ours, this will demand hard work, ability to adjust ourselves as situations change, and sometimes a good bit of forebearance.

You won't like all your instructors. You won't like all your courses. You won't see the sense in all of our procedures. There may even come a time when you proclaim loudly, and in words that I know but can't print, "If this is what they think it takes to be an engineer, they can have it; I don't want any of it."

All this is natural enough. If and when it happens, don't let it throw you. Simply do three or four things. Analyze yourself—including the strong and weak points of your temperament—just as impersonally as you would analyze some physical material. Recognize that, for all of us, hard work will greatly shorten most periods of doubt and discouragement. Act upon the facts that you can help yourself to orientate yourself if you will make new friends and if you will take some part in extracurricular activities. Finally, remember that you can always get counseling from your departmental adviser, from the Associate Dean and Assistant Deans of the College, and from the University Counseling Bureau as well.

In other words, do the same sort of things that the rest of us do when we hit a dry spell; size yourself up, keep plugging but get recreation too, and talk things over with some of your many friends.

The long and short of it is that your years here are not years apart from "life." They are a part of life. It is true that in one sense you are "preparing for life." But the preparation doesn't take place in some fourth dimension. While you are preparing, you are at the same time living.

For instance, the material in your scientific and engineering courses isn't just textbook stuff. It is drawn from, and points toward, what you will find and do on the job. Your teachers aren't pale imitations of people. They are people, engineering people. They keep in close touch with what is going on in the field, and in the factories, and in the research labs that help to determine what will be going on in field and factory soon.

The same for your fellow students. They aren't actors in a preparation-for-life play. They are part of life. They are the same kind and variety of people whom, for many years, you will be working with, living beside, arguing with over Dodgers and Cubs, sales taxes, school or drainage bonds, Iran or Egypt or the East Indies, donkey versus elephant.

So live your four years here to the fullest. Think of yourself as an engineer, a member of an honored profession. Think of yourself too as a citizen, willing to assume the duties, as you enjoy the benefits of citizenship. Think of yourself as a University man or woman, with all that that implies of freedom from prejudice and liberality of outlook. And act as you think.

W. L. EVERITT

introducing . . .

by Duane Loofburrow, Gen. E. '53, Martin Goldstein, Chem. E. '55
and Bob Schrader, Chem. E. '54

PROFESSOR WILLIAM S. POLLARD

"I don't teach during the summer in order that I may gain further experience," said Professor William S. Pollard, an assistant professor of the civil engineering department. Professor Pollard came to Illinois in the fall of 1949 after having secured his master's degree from Purdue in 1948. He obtained his bachelor's degree from the same institution in 1946.

Professor Pollard's courses deal chiefly with highway engineering in which field he engages himself during the summer. He feels that except for the fact that the more mature element which had been presented by the veterans is almost entirely gone now, there is little difference between students now and when he was working toward his degree and first began teaching.

Photography is Professor Pollard's chief hobby and his master's thesis dealt with this subject in some degree. It was entitled "Interpretation of Engineering Soil Types from a Study of Aerial Photographs." At present he maintains two cameras; one for black and white and one for color.

PROF. WILLIAM S. POLLARD

Besides keeping busy with his wife and one son, Professor Pollard is one of the faculty advisors of Chi Epsilon, the civil engineering honorary. He is also a member of Sigma Xi, scientific research honorary, Theta Xi, social fraternity, and a junior member of ASCE.

AL VEJAR

Al Vejar, our new editor of the Technograph actually needs no introduction. He has introduced himself through several fine articles during the past year. But though you already know Mr. Vejar, we thought you would like to hear a little more about him.

Al is a transplanted Californian. He was born in Los Angeles, but later moved to Danville, Illinois. He graduated from Danville high in 1949 and continued on to school at the University of California in Berkley. Al pledged Pi Kappa Alpha and later served as historian for the fraternity. He was very active in all phases of campus life, being an assistant editor of the California Engineer, treasurer of the University of California symphony forum, publicity director for the sophomore class, and a member of the sophomore council.

Al transferred to Illinois in September, 1951. In addition to his work on the Tech staff here, Al has been a student senator, regional vice president of Student Affairs for the NSA, and chairman of the Student Senate Educational Affairs committee.

Al's hobbies include firearms, sports cars, sailing, and travel. He went to Japan, China, and the Philippines last summer and, traveled from Canada to Mexico this summer, covering 36 states in between. His love life centers around a Kappa Kappa Gamma named Gretchen Guin, "with whom," Al says, "I have been engaged, pinned, and semi-permanently unengaged over the past four years."

As to his future plans, Al would like to make his home in or around San Francisco. Being an ROTC enrollee, his plans for the near future are already decided.

PROFESSOR W. C. HUNTINGTON

As head of the civil engineering department, Professor W. C. Huntington brings to engineering at Illinois a wealth of experience, both in educational work and in practical engineering.

Professor Huntington graduated from the University of Colorado in 1910. After working in the field for a year, he returned to Colorado as an instructor and as a structural engineer for Dean M. S. Ketchum who carried on a consulting practice. In 1917 he was placed in charge of the university construction program, and in 1919 was made head of the Civil Engineering Department. In former capacity he did the preliminary planning and structural design and was responsible for the construction of several of the buildings, constructed of stone from the nearby mountains, which have made the Colorado campus one of the nation's most beautiful. During this period the Colorado football stadium was built. The stadium was of the sunken bowl type, fitting neatly into the natural contour of the ground. The surveying for the stadium was done as a student project. The advantageous site made it possible to construct the 25,000 capacity stadium for only two dollars a seat.

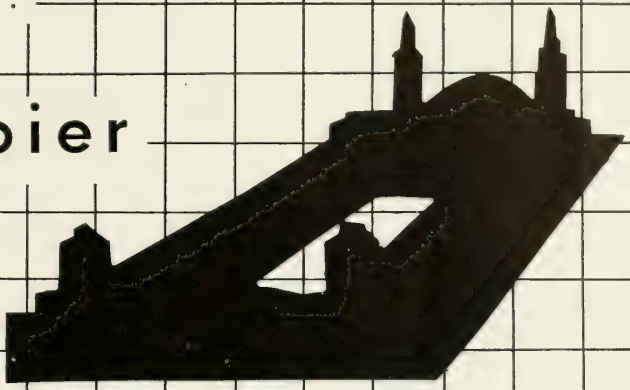
AL VEJAR

Professor Huntington came to Illinois in 1926 as head of the Civil Engineering Department. During his stay here he has had many responsibilities other than those of a department head. In 1933 he was assigned the task of forming an engineering organization for the Civil Works Administration in Illinois which was the forerunner of the PWA. This organization was responsible for administering $60 million worth of projects employing a peak of 234,000 men. In 1935 the CE staff, together with the staffs of the State Geological and Water Surveys, studied the possibilities

(*Continued on page 40*)

— the university of illinois at . . .

navy pier



Bruce Burgess, Editor

PIER IN THE PUDDLE

The name engineer was first applied by the Romans to the Military men who made the roads and bridges and works of "water-supply" for their military campaigns. These men later were formed into units and called Military Engineers. When the wars were suspended, these engineers turned their knowledge and skill to making roads and water-supply plants and lines for Rome and other cities of the Roman Empire. Shortly thereafter they were called civilian engineers. This term included everything except military engineering.

The meaning of Civil Engineering is now restricted to apply principally to the design and construction of railroads, bridges, buildings, canals, docks, harbors, tunnels, roads, sewers, and water-supply and treatment works.

The curriculum in Civil Engineering is such a broad one, that men trained in this field can be found at the top in all walks of life.

All civil engineering students are enrolled in the same courses — with a slight deviation for sanitary and hydraulic engineers—for the first three years of their college career, specializing in their fourth or senior year.

The curriculum at the Navy Pier covers the first two years of the civil engineering curriculum, after which the student is automatically transferred to Urbana to complete his last two years. At Navy Pier the basic mathematics and physics is given along with courses in building construction, concrete and surveying. The boys at Navy Pier join with those at Urbana yearly at a surveying camp in Northern Minnesota. Here, for five weeks the boys are given field practice in surveying, returning to school in the fall to complete their surveying education with a course in route surveying.

At Navy Pier, civil engineering students have an active student chapter of the American Society of Civil Engineers. They also belong to the mid-west conference of Student Chapters along with eighteen other mid-west engineering schools. The last meeting of this conference was held at Iowa State College at Ames, Iowa. Mr. Robert Olafson of the Navy Pier was elected President for the ensuing year, the conference will therefore be held at Navy Pier sometime next April.

The Student Chapter at the Pier is very much alive and the members hold annually a picnic and a dance. These are closed affairs and only civils and their dates participate. The boys have a lot of fun and good fellowship.

Last October the Student Chapter sent its President, Mr. Ben Svoboda, to represent them at the Annual Meeting of the American Society Civil Engineers in New York. The annual meeting of the Parent Society this year and incidentally its hundredth anniversary will be held in Chicago. The civil students at Navy Pier along with students from Northwestern and I. I. T., will take an active part in the convention.

Each year in April the U. of I. at Navy Pier holds an Open House to which the parents and friends of all students are invited. The civils always have an exhibit typical of what has been done in class work. Samples of student work was exhibited as well as extra-curricular activities. Several students brought in the results of their hobbies this year. The interest that was shown in our exhibit indicated that the Open House was very successful. J. C. Chaderton is the Sponsor of the Student Chapter of Civil Engineers at the Pier. High school students are invited to come in and talk over their ambitions with him.

ENGINEERING SOCIETIES

AIEE-IRE

At the May 12 meeting the election of officers was held and the following members were elected:

Donald Davoust — Chairman
Paul Lifka — Vice Chairman
Norman Horn — Secretary
Ronald Sparks — Treasurer
Jack Campbell — Student Engineering Representative.

After the election proceedings an animated movie describing the basic principles of jet propulsion was shown. The society is planning a well regulated and full program for this fall.

AIA

The American Institute of Architects, student chapter, Navy Pier, held a picnic June 11th in Thatcher's Woods as a climax to an outstanding semester.

(Continued on page 40)

skimming industrial headlines

edited by Charles LaRobadier, M.E. '55

Power for Defense

This 37-ton segment is one of three such parts that make up the stator of a 35,555-kva generator being built by Westinghouse at East Pittsburgh, Pa., for the U. S. Engineers' hydro-electric project at Buggs Island, Virginia. Power generated at the Roanoke River dam will be utilized at Langley Field, an important air base near Norfolk. Six such generators will be built for this project.

Glycerine Solves a Glass Industry Problem

W. T. Davies, Plant Manager of Applicolor, Inc., has cited glycerine as having been the solution to what he calls the toughest ceramic problem he ever faced in his 25 years in the industry. The problem came up in the automatic, over-all spraying of glass jars and bottles with glass enamel. Flint glassware worked well in the process, but opal glass—the smooth, opaque glass used for cosmetic and ointment jars—behaved as if it were in some way contaminated with oil. As soon as the spray hit the enamel would tear or break, with the result that usually more than 50 per cent of each run had to be wiped off and sprayed over. This, of course, ruined production and ran costs up enormously.

Several cures for the trouble were tried without success, and finally in a search for wetting agents, mixtures of glycerine and alcohol were used. In Mr. Davies words, the results this time were amazing. As soon as the enamel containing the combination of glycerine and alcohol reached the opal ware, tearing stopped and the enamel went on smoothly and without interruption. Four to eight ounces of a 13 per cent glycerine in alcohol solution in each 50 pounds of enamel slip was found to give the best results.

A 37-ton stator part for a large generator. (Courtesy of Westinghouse.)

Aircraft Armament Carrier

Final check is being made on a production model pylon prior to its shipment to Republic Aviation Corporation, Farmingdale, New York. The pylon is suspended beneath each wing of F-84 Thunderjets and is used to carry auxiliary fuel tanks or armament such as bombs, rockets, or napalm tanks. The electrical and air control system permits jettisoning fuel tanks or armament and, if necessary, the pylon itself. The pylon, which requires extremely precise manufacturing techniques, is being produced by Westinghouse.

Making a final check on production model pylon prior to shipment. (Courtesy of Westinghouse.)

Electrical Deodorant

In 1945 Westinghouse introduced a deodorizing lamp that utilized ozone to destroy odors. This lamp emits ultraviolet rays with a wave length of about 1850 Angstom units. These radiations change some of the oxygen surrounding the bulb into ozone, which then oxidizes the odor molecules in the air. Thousands of these ozone lamps are used in clothes dryers, washers, and in beverage machines. Now, as a result of a completely unrelated lamp engineering investigation, a more powerful deodorizing lamp has been developed.

The new lamp, called the Odorout, was developed by F. H. Rixton of

(*Continued on page 32*)

Nature was working for you...a billion years ago

Age-old natural gas—changed beyond recognition by the hand of science—is in nearly everything that's new today

Geologists tell us that centuries ago mountains rose and crumbled . . . oceans formed and disappeared . . . and great masses of plant and animal life were buried under layers of earth, rock, and water. Gradually, chemical reactions changed that buried matter into oil and natural gas.

IT IS IMPORTANT TO ALL OF US—Natural gas came into its own within the lifetime of many of us. Its great importance began when scientists learned to separate and use its parts. Out of this work in the field of petro-chemistry came "Prestone" anti-freeze, the all-winter type that took the worry out of cold weather driving. Then there are today's plastics. Some are so soft and pliable that they make beautiful, long-lasting curtains and drapes for your home. Others are so tough and enduring that they are used to protect the bottoms of ocean liners. Natural gas products are important ingredients in nearly all of them.

FROM ANTI-FREEZE TO FUEL—Wherever you turn, there's something that's been made better by the magic touch of chemistry. It brings you many of today's life-saving wonder drugs . . . man-made fibers for exciting new textiles . . . hundreds of useful chemicals . . . and also "Pyrofax" gas, the modern bottled gas for home, farm, and industry.

UCC AND CHEMISTRY—The people of Union Carbide pioneered in producing synthetic organic chemicals. Today, their plants turn out more than 350 of these versatile chemicals for industry to use in making the things that serve you so well.

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DYNEL TEXTILE FIBERS • BAKELITE, KRENE, and VINYLITE Plastics • LINDE Oxygen • SYNTHETIC ORGANIC CHEMICALS

mineral exploration by . . .

Airborne Magnetometer

by Martin Goldstein, Chem. E. '55

The airborne magnetometer recently discovered a massive magnetite body, overlooked in many past ground studies, in eastern Pennsylvania. The body which is at a depth of 1,500 to 3,000 feet shows no apparent surface expression. The aeromagnetic survey, flown by Aero Service Corporation, covered 900,000 acres and cost less than 7c per acre.

Extensive ground exploration in this part of Pennsylvania yielded many discoveries, but no really important large ones. Since magnetite, a highly magnetic ore, was expected, the use of the magnetometer was indicated. It was chosen for six reasons:

1. High sensitivity.
2. Continuous record.
3. Freedom from surface accidentals.
4. Speed and detail.
5. Successful exploration record.
6. Conclusiveness of its survey.

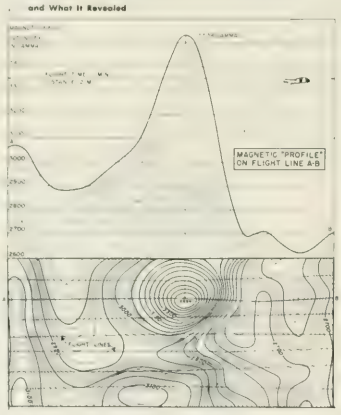
Since the ground studies had been scattered and inconclusive due to gaps caused by terrain difficulties and property considerations, the geologists knew that only the aerial survey permitted a quick, broad, conclusive search.

Three test magnetometer flights—one at 300 feet, one at 500 feet and one at 1,000 feet, all flown with the flight traverse perpendicular to the structure—were flown over a known magnetic body. A satisfactory signal at 500 feet terrain clearance, a convenient and safe operating altitude, led to this height as the normal altitude.

Although the 30 day survey showed many significant magnetic highs, many as much as 5,000 gammas variance in a few seconds, all were not commercial orebodies. The readings, however, did reflect differences in sub-surface structure, but it was necessary to correlate the geologic information in the field with the magnetic data to determine the significance of the magnetic record.

It was established that the aerial survey uncovered a massive concentration of magnetic ore in the Paleozoic limestone underlying the Triassic sediments of the area. Later diamond drillings established the body lay at a depth of 1,500 to 3,000 feet with practically no surface expression, but the magnetic information alone permitted property acquisitions.

The survey plane was a twin-engine Beechcraft, a stable workhorse craft which has been extensively used in surveys in the United States and Canada, with complex electronic recording equipment. Because a motor failure in a single-engine plane at 500 feet is not



A magnetic peak, such as this, was picked up over an iron ore deposit by an airborne magnetometer and recorded on a continuous tape.

healthy, a twin-engine craft is always used for low-altitude aeromagnetic work.

The magnetometer employed was the high sensitivity instrument pioneered and developed by the Gulf Research and Development Company in 1947. It is especially useful in mineral surveys because of its great speed of response. The Gulf instrument responds dependably to a great variation (10,000 to 15,000 gammas in a short distance with the survey plane moving at about 200 feet per second), and it is connected to a Leeds and Northrup recorder, adapted to keep pace with the rapidly changing peaks and valleys of the magnetic signal. Since the magnetic record must be made precisely and quickly to keep the significant differences from being lost, it is the key to the survey success.

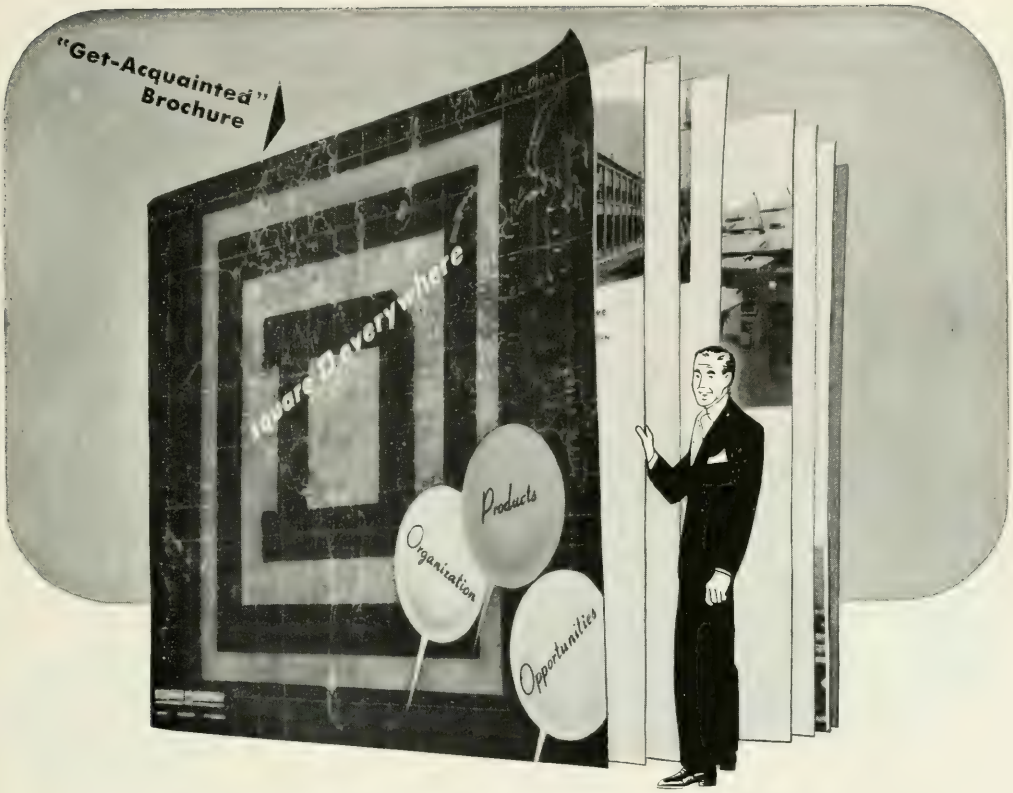
The plane's terrain clearance was continually recorded with a special RCA recording radio-altimiter, and the flight path was recorded with a "Sonne" camera, a gyrostabilized strip 35 mm. camera. At frequent intervals the Sonne film and the magnetometer tape were marked, so that the magnetic record and flight path are clearly correlated.

The survey flight lines were laid out at ¼-mile intervals roughly at right angles to the regional strike, on existing topographic maps obtained from the U. S. Geological Survey. Photo-mosaics, to which these lines were transferred, were used for actual flight guidance, and for identification of the flight path photographs. This survey was flown in midwinter as aeromagnetic surveys often are, with correlating ground studies planned for spring and summer work.

The survey crew, consisting of a pilot, co-pilot photographer and magnetometer operator, took off each day at daylight and on second flights flew almost to dusk, covering as many as 100,000 acres in a single day. Each night the film was developed and inspected and the magnetometer and altimeter records checked.

Since the "raw" magnetic data is often significant for so strongly magnetic a material, geologists studied the results of the survey each day. (With less magnetic materials the field work would wait for magnetic intensity maps to provide a broad picture of trends within the area.) Though Aero Survey has compiled a dependable 1 Gamma map, the usual maps are at 5 or 10-gamma contour intervals.

Today, when there is a growing interest among companies in blind areas contiguous to known deposits, the aeromagnetic method makes it feasible to canvass such areas rapidly, economically and conclusively. It appears that a number of mining companies will use this tested new exploration tool to do this.



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But Lockheed offers you more than a career. It offers you a new life, in an area where living conditions are beyond compare. Outdoor living prevails the year-'round. Mountains, beaches are an hour from Lockheed.

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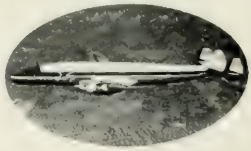
This Plane made History

The P-38 Lightning – first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History



The Super Constellation – larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

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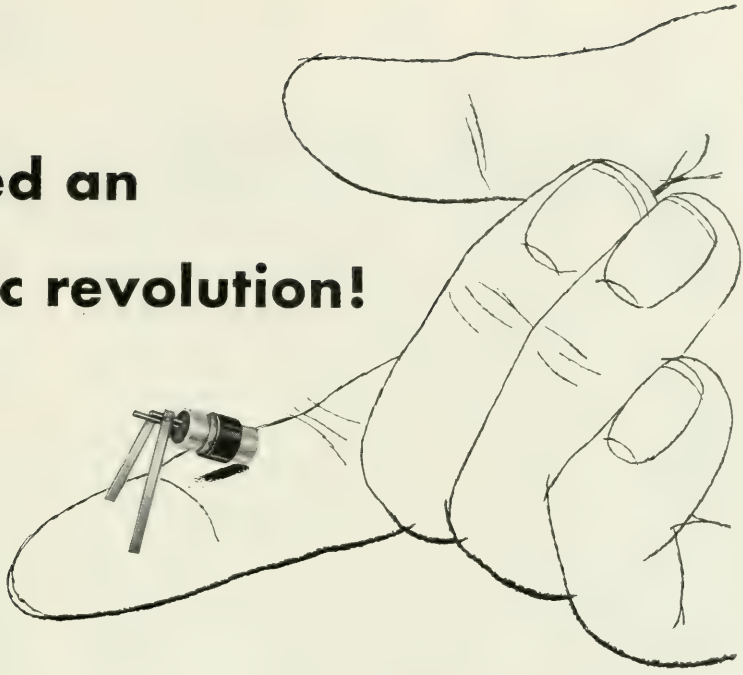
The jet of the future – the plane you will help create—belongs here.

This plane – which exists only in the brain of an engineer like yourself – is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.

It sparked an electronic revolution!



The 2A Transistor illustrated is designed to fit a plug-in socket. In one use in the Bell System, ribbon leads are employed as shown above.

Perhaps you've heard something about the transistor—a tiny and mechanically simple electronic device based on an entirely new principle. It can do many things a vacuum tube can do—yet its greatest possibilities may lie in applications where vacuum tubes have *not* been used.

A few years ago this revolutionary device was invented and experimentally made by scientists at Bell Telephone Laboratories. Today, several types of transistors are in production at Western Electric—manufacturing unit of the Bell System.

This didn't just happen! Its manufacture is the result of a lot of teamwork by Western Electric engineers of varied skills and training.

Transistors are unimpressive looking little things, but don't let that fool you! The most delicate metallurgical and manufacturing skills are required in their production. In one type of transistor there are three thin adjacent regions of germanium, each region containing chemical elements in exact quantities, the whole unit being no larger than the head of a match! Suitable leads, or wires, must be positioned in proper relation to these layers with utmost accuracy, using microscopes and oscilloscopes.

Transistors can do many things: transform radio energy for driving a telephone receiver or loudspeaker—amplify weak signals—generate a-c current—convert a-c to d-c—respond to light—increase, decrease or halt the flow of current. Small and rugged, they're going to work today in the Bell System and in varied types of military equipment.

Quantity producing these mighty mites—with laboratory precision—is typical of many forward-looking engineering projects at Western Electric.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

by Oliver Smith, M.E. '54

While looking in the Farmers' Almanac for a good day to go fishing, I came across an amusing recipe which seemed a little unusual, but nevertheless, should produce good results. Here it is:

RECIPE FOR EDUCATION

Take a cup of thinking, 2 cups of dreams, from 4 to 8 years of youth (depending on how strong), 3½ cups of persistence, 3 teaspoons of ability, 1 cup of cooperation, a teaspoon of borrowing, 1 cup of good books and lectures and teachers, 1 cup of health, and 1 cup of plans made and followed through. Cream the thinking and the dreams. Add the years and beat until creamy. Sift persistence and ability together and add alternately with the cooperation to the first mixture. Add borrowing books, lectures, teachers, health and plans. Fold in the years of youth, beaten stiff. Bake in any moderately good college or university. Time in college, 4 or more years, depending on how you like your cake. Temperature, plenty hot. Servings will last for life.

* * *

At a recent bull session we happened to get on the subject of honorary societies when someone brought up Phi Beta Kappa. This honorary organization, which requires one to rank in the upper ten per cent of his class for membership, has one of the strangest lists of people among its ranks. Among the many notables are Bob Taft, Dr. Ralph Bunche, Fred Vinson, Bernard Baruch, and twelve former presidents of the United States. Moe Berg, catcher for the Boston Red Sox, Jeanne Cagney, and Tommy Tucker also show the variation in members. The ones that proved amusing were the less notables, but nevertheless interesting individuals. Take, for instance, the flag pole sitter, the professional roller skater, a pickpocket and even a man who lives the life of an eskimo in the Arctic because he wants seclusion. To top it off, a man and wife, who both hold the key are proprietors of a nudist camp in Idaho.

* * *

Once again, just for their sheer love of knowledge, millions of students flocking back to their institutions of learning. To most of us it means another year of working and struggling to pass a course with the highest mark attainable. What's the use of overdoing it though, and going into a hermit stage cutting off all contact with society?

So many individuals that are known to us will bury themselves in their books and, although it is definitely unnecessary, will stay there until the semester is completed. They feel that they have no time for anything else, and in the majority of cases, they don't. Students will cuss up and down that they are getting too much homework and that their instructors are unfair with them. I am of the opinion, however, that the fault lies with the student rather than the instructor.

Common to all of us are those individuals who will sit and gripe all night when they have a load of homework rather then digging in and getting it done. Then when they do finally resign themselves to the fact there is no alternative but to get started on homework, they spend all night on one subject and scribble something on the paper to hand in for the other subjects, so as to get at least partial credit.

It has come to my knowledge that studying can be done more efficiently if some sort of a system is used, or a definite procedure is followed. By making a few considerations one can easily work out a system to use in his studies.

The first thing to consider is the time element. By taking a couple of minutes before you dive into your work for the sole purpose of determining how much time you will spend on each subject, you will not be caught with a multitude of work to be done in an hour or so. Divide your time, putting the important courses first, so that if anything does happen to hinder your studies you will at least have the "heavier" subjects out of the way. If you finish the homework for one of your courses ahead of time don't hesitate to go directly into the next subject. By no means should you spend more time on any one subject than you have planned this will disrupt your whole schedule. If, by a strange twist of fate, you should finish early then you can go back and complete something that you left earlier in order to go to the next subject.

The comfort of the individual also plays an enormous part in studying. It would be well to put yourself in the environment that is most conducive to studying. Have everything handy so that it won't be necessary to start running hither and yon while you are at work. Seat yourself in a comfortable position with good light. Be as far removed as possible from any distractions. In short, make an attempt to procure the utmost in personal easiness.

The things mentioned above are just some suggestions in regard to studying. It is not so important that you precisely follow these instructions, but that you make an earnest attempt to systemize your school work. Different individuals will use different methods according to their needs. This business of systematic studying is not just a lot of bunk—it works! Why not give it a try?

* * *

Supersalesman: One who sells a prefabricated garage to a purchaser of a rattle ticket for a new car.

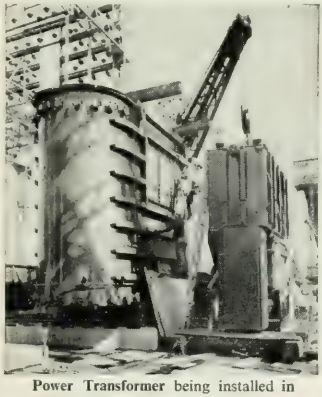
Make the First Job Count!

by PAUL CLARK
Application Engineer, Electric Control Section
WEST ALLIS WORKS
(Graduate Training Course 1950)
Iowa State—EE—1949

IT SUDDENLY occurred to me while I was a senior, looking for a job, that my first job would be all important. In a way, it was going to be almost as much a part of my schooling as my last year at "State."

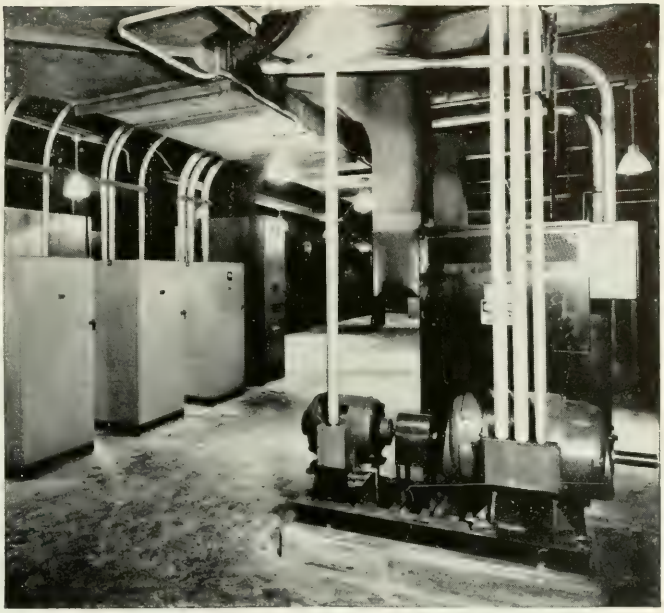
PAUL CLARK

Since then, I've been glad I thought of it that way, because that's what the first year and a half was . . . schooling. Among other things, I learned what I wanted to do, and learned a lot about products and industry problems. But I give much of the credit for the great amount I learned to the Allis-Chalmers Graduate Training Course and consider myself very lucky to have chosen Allis-Chalmers. Perhaps a quick review of my own experience will show why I feel that way.


Power Transformer being installed in Midwest utility.

After graduating from Iowa State in 1949

I started the Allis-Chalmers Graduate Training Course on the Steam Turbine erection floor. From there I went to the switchgear and pump departments to familiarize myself with other utility equipment; and from there, to the Motor and Generator section, which at the time was my goal.


Brain of a giant 107,000-kw steam turbo-generator is this complex *Regulex* voltage control. Clark finds such control a fascinating problem.

Arrange Your Own Course

From this, you begin to see the freedom a GTC student has at Allis-Chalmers. You not only have complete freedom in arranging your course, but you can change your course as you go along and your interests develop. Best of all, you have a wide choice, because Allis-Chalmers builds such a wide line of products.

Even after getting to the Motor and Generator section, which had been my original goal, I had a chance to change my mind. While I found a certain glamour to the big motors and generators, I became *really* intrigued by the electrical brains of these giants, and decided to go to the control section to learn more about them. I have been working there ever since.

Today, I am in charge of pricing, applying and promoting the sale of three lines of control devices: *Rocking Contact* voltage regulators; *Regulex* voltage regulators; and liquid rheostats. Part of my time is spent traveling . . . visiting customers and helping district office salesmen.

The time spent in other departments has paid off too. It not only helped me find the work I liked best, but I met people in departments all over the plant that I now work with in coordinating jobs for utilities. Even time on the Steam Turbine erection floor proved valuable, because it helps me in talking shop to utility men.

Wide Choice at A-C

One reason you have such a wide choice is the fact that Allis-Chalmers makes equipment for every basic industry, including electric power, cement, mining, rock products, flour milling, and steel. Just to give you an idea, here are some of the products you might some day redesign, build or sell: transformers, steam condensers, pumps, motors, blowers, unit substations, steam and hydraulic turbines and generators, crushers, kilns, grinders, coolers, rolling mills, sifters, and many others.

That diversity can mean a lot to you in helping you find the job you want. It certainly helped me make my first job count.

Rocking Contact and *Regulex* are Allis-Chalmers trademarks

ALLIS-CHALMERS

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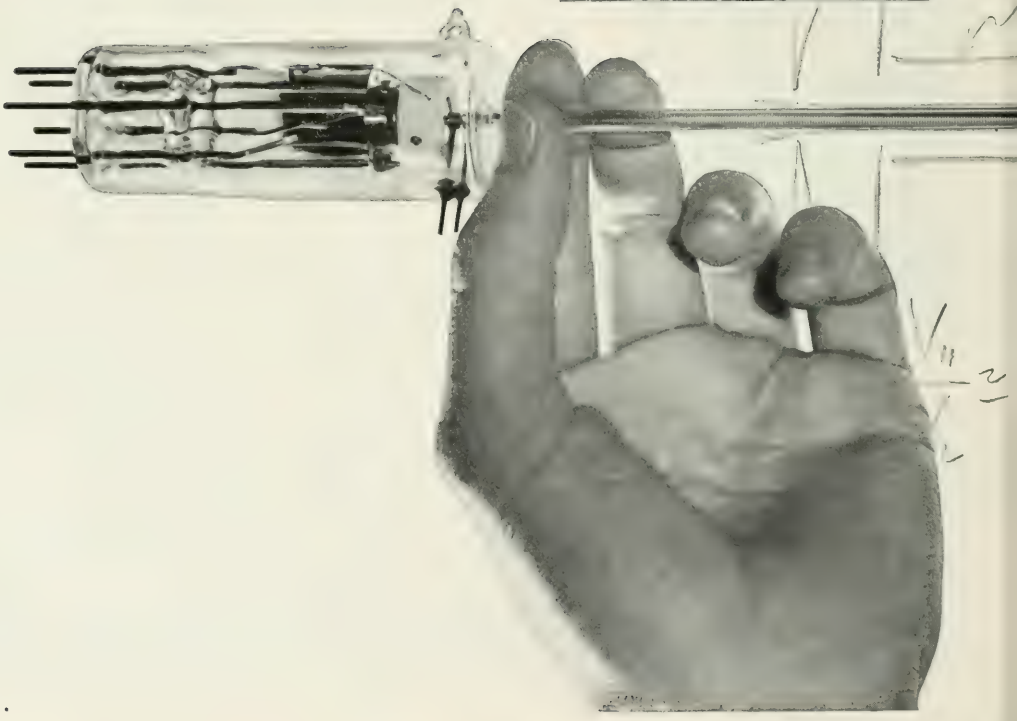
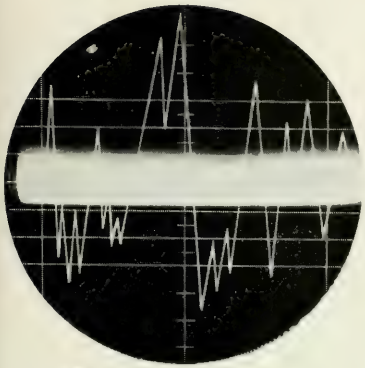
Reducing **noise** in radar...

Measuring the noise figure of an experimental traveling-wave tube are Dr. A. V. Haeff (right) head of the Electron Tube Laboratories at Hughes, and Dr. Dean Watkins (left) one of his co-workers.





In the operation of a radar system, the amount of energy reflected from small targets is very minute. The over-all sensitivity and range of radar depend equally upon effectively generating and transmitting considerable power at microwave frequencies—and upon effectively receiving and amplifying very weak echo signals.

An important limitation in receiver sensitivity is imposed by noise that is created within the receiving tubes—and caused by random motion of electrons. Because the reduction of tube noise could make available improved techniques to the designer of many types of microwave systems, a project is under way at Hughes Research and Development Laboratories to expand our understanding of noise phenomena at high frequencies.

Studies in tube noise are being made with the newly developed *traveling-wave tube,* shown on this page in actual size. This tube has the unique ability to amplify microwave signals over a wide frequency range, but its excessive noise has hitherto prevented its extensive use. Methods of reducing noise in the traveling-wave tube are being devised and tested at Hughes, and the recently obtained noise figure of 13 decibels at a frequency of 10,000 megacycles is proving of considerable interest to systems designers.

Positions for engineers and physicists are available in the Research and Development Laboratories. If you would like to learn more about these positions, and are not now engaged in an urgent military project, write to:

Hughes Research and Development Laboratories
Engineering Personnel Department
Los Angeles County
Culver City, California

AERIAL PHOTO . . .

(*Continued from page 9*)

erty in southern Illinois was accomplished at $1.84 per acre, whereas ground surveys for a nearby 2,045 acre tract with similar terrain cost $2.92 per acre. Both were mapped at a scale of 1 inch equals 100 ft., and the contour interval was 5 ft. In general, maps at a five foot contour interval cost upward of $1.50 per acre; 10 ft. interval, 60c per acre or more; 20 ft. interval, 35 to 50c per acre. Of course, the cost of each mapping must be estimated separately.

Photo-maps or mosaics vary in cost too, according to scale and the size and shape of the area. This cost is in the 4 to 6c per acre bracket. This includes the individual photos for stereo study.

Production of the Maps

The aerial photographs are the base for both the photomosaic and the aerial topography map. Before assembling the mosaic, the photos must be corrected for minor tilt which occurs because the airplane cannot be maintained in absolutely level flight. Adjustments are made too for the scale difference in photos. These occur because the mapping plane photographs peaks and valleys from the same fixed altitude so that the peaks appear at a larger scale and the valleys at a smaller scale than actually exists.

Compilation of mosaic or photo-map is not simple a routine of glueing or tacking the aerial photos to a base as you would assemble the pieces of a jigsaw puzzle. First, grids are plotted on the base or plot board over which the mosaic is assembled. Next, the coordinate positions of the control points are indicated on the board. These control points are marked on the aerial photos, and then the photos are placed in position on the board. The photographs do not match and fit together perfectly because of the tilt and difference of scale unavoidable in aerial photography. So a comparison is made of the true distances on the plot board and the distances seen on the aerial photo to establish how much the photo must be tilted, enlarged, or reduced to fit in true horizontal position in the finished mosaic. After corrected prints have been made, they are marked with the control points and assembled on the plot board, with each photograph placed carefully in its correct position. This composite is then copied as a photo-map.

Compilation of the topographic map from an aerial photographic base is a more complex and precise process. After the tilt in the original photographs has been corrected, they are viewed in stereo-plotting devices of great precision. The stereo-plotting instrument gives a third-dimensional view of aerial photographs, and the operator drafts the successive elevations until each pair of photos has been contoured. The individual contoured sheets are then assembled and the finished map tracing is made.

In aerial topographic mapping a minimum amount of ground control is needed. Field-survey parties obtain nine vertical control points for each pair of photos, and the horizontal control is made up of several points established along each flight strip. By using the new Wild theodolite, vertical and horizontal control is run simultaneously. With the network of ground control and the stereo pairs of photographs, contouring with the stereo-plotting instruments can be done much more rapidly than plane tabling and interpolating field notes. Moreover, the aerial topographic may is more complete since details such as ponds, buildings, power lines and fences are recorded. In aerial mapping the practice is to overfly the area to obtain the boundry features. In addition, the maps serve as a base to plot property owners' names, drillholes, outcrop and other data.

Uses Other than Mining

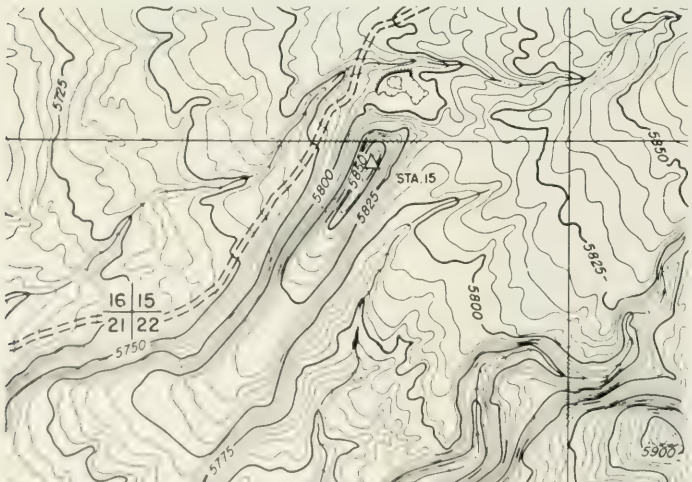
For the first time, in the fall of 1950, Philadelphia Electric Co. inventoried the 39 coal piles in its 10 widely-scattered storage sites from the air using aerial photographs and modern stereoscoping mapping techniques instead of rod and level surveys on the ground. These are the benefits that were obtained:

1. Final fuel inventory figures were obtained in 10 days instead of several weeks.
2. A single inventory date was obtained for all stockpiles.
3. Results accurate within 3 to 5 percent.
4. Cost of inventory was cut 25 percent.
5. Survey personnel were freed for other important work.

Until two years ago the company had used conventional topographical survey methods on the ground to determine the contour and volume of coal piles. Three years ago this inventory method required 225 man days and interrupted the regular work of the surveyors during the period of the inventory. There were other headaches too. Some of the stockpiles took several days to survey. Additions or withdrawals from these piles changed their volumes and made corrections to a single inventory date difficult if not impossible to accomplish with any degree of accuracy.

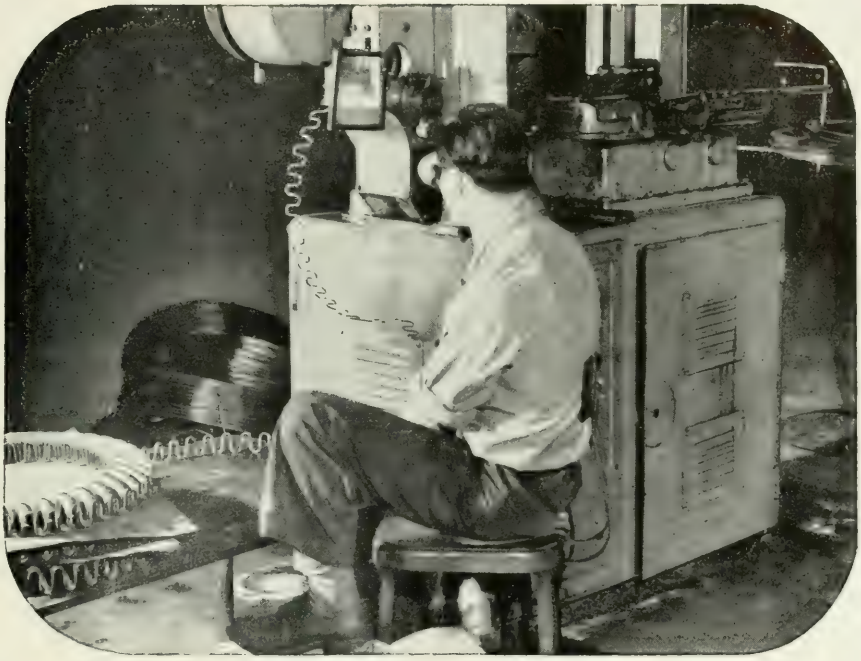
Company coal stockpiles are located within a 30-mile circle in Philadelphia and the four adjacent counties. Accordingly, it was possible to take the necessary aerial photographs of all ten storage sites in a single afternoon. When a good mapping day occurred, the utility ws notified that the photographs would be taken and the approximate time when the plane would be over each stockpile site. Company personnel on watch noted the time, and the mapping plane flew over at an altitude of 1,200 ft., and so fixed exactly the inventory hour.

(*Continued on page 32*)



Although not quite as accurate as the topographic map, the aerial contour map records a wealth of cultural detail in true relative scale.

SPRING WIRE



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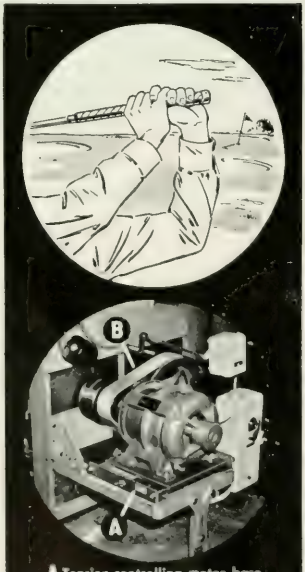


A Tension-controlling motor base
B Flat leather belt

AL-56

American LEATHER BELTING *Association*

Headquarters for Authentic Power Transmission Data

320 Broadway, New York 7, N. Y.

WANTED . . .

(*Continued from page* 11)

the Bureau of Land Management and the United States Lake Survey require many civil engineers annually, and some projects are country-wide. The U. S. Coast and Geodetic Survey for example is currently working in Alaskan waters, making extensive harbor and shore surveys using electronic triangulation. Working with such an agency can acquaint the engineer with the latest methods and equipment. It is probably more true here than any where else that the engineer never really can stop learning.

Opportunities in a few of the fields employing civil engineers have been mentioned. The list is by no means complete, we haven't even mentioned the teaching of civil engineering which certainly requires an extensive force. The civil has before him a vast range of interesting employment possibilities. The field he chooses is limited by his own interests. He can develop in this field as much as any engineer can do in any field. The year 1952 marks the end of the first century of "Engineered Progress," progress implies advancement and the young engineer will contribute as much to that advancement as those engineers going before him have contributed. Today the opportunities are unbounded.

Some members of the Hoover Committee were questioning a civil service worker in Washington. "What do you do here?" they asked him.

The clerk, fed up with red tape, buck-passing, office politics, and above all, efficiency experts, answered, "I don't do a darn thing."

The committee went into a huddle, made a few notes, then asked the second man, "And you, what's your job here?"

"I don't do a thing either."

The committee leader's ears perked up. "Hmmmm," he said, "I suspect that there's duplication here."

* * *

"Look at that man swimmin' out there. Isn't he afraid of sharks?"

"No, he has 'Ohio State University is the best college in the United States tattooed on his chest, and even a shark couldn't swallow that."

* * *

Here's to the CE lying on the floor; he tried to slam a swinging door.

* * *

Student: "What do you mean by horse sense?"

Professor: "You might define it as stable knowledge."

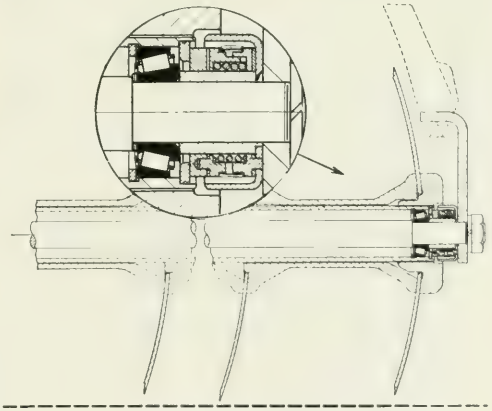
Another page for **YOUR BEARING NOTEBOOK**

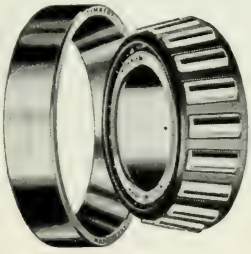
How agricultural engineers solve 3 design problems at once

Designing farm machinery applications like the through shafts of disk harrows presents three big problems to agricultural engineers: 1) combination loads, 2) dirt, 3) ease of operation. Engineers solve all three problems at once by designing the shafts on Timken® tapered roller bearings. Because they are tapered, Timken bearings carry both radial and thrust loads in any combination. They keep housings and shafts concentric, making closures more effective. Dirt stays out—lubricant in. And they keep shafts turning easily because of their true rolling motion and incredibly smooth surface finish.

How to mount disk harrow shafts on TIMKEN® bearings

Two single-row Type TS Timken bearings are indirectly mounted on a stationary shaft in a rotating disk assembly. The bearing cups are press-fitted against snap rings. The bearings are adjusted by means of shims between the bearing cone and shaft shoulder. A special spring-backed rubbing seal assures maximum protection to the bearings. The rubbing seal itself is protected by a shield fitted about the closure assembly.





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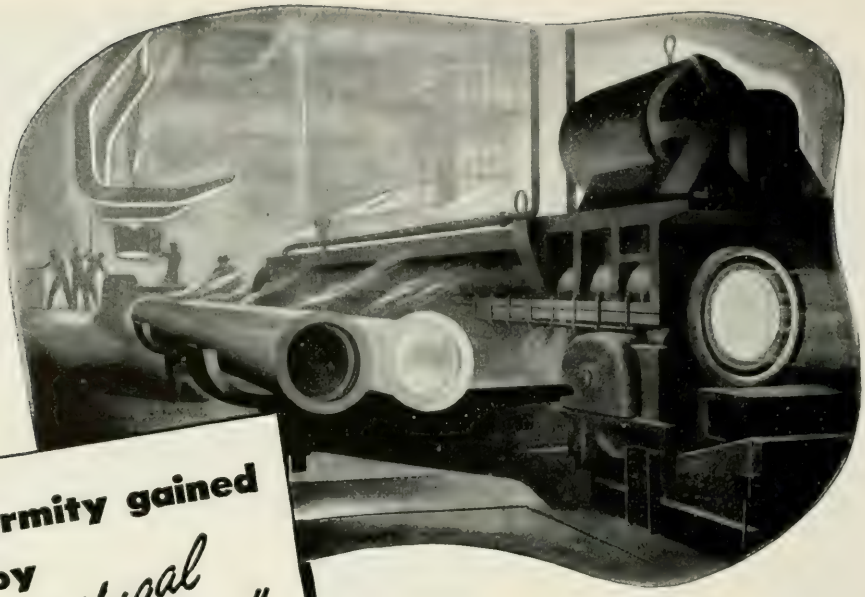
TAPERED ROLLER BEARINGS

How to learn more about bearings

Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For a copy of the 270-page General Information Manual on Timken bearings, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ⓪ AND THRUST —⓪— LOADS OR ANY COMBINATION ✳



Uniformity gained by "Centrifugal Casting"

The great majority of cast iron pressure pipe produced today is cast centrifugally, in metal or sand-lined molds.

When this mechanized process was introduced 27 years ago, its potentialities for improved production controls were evident. For human fallibility was largely replaced by machine accuracy based on scientific principles.

The improved production controls made possible by the centrifugal casting process have long since been realized. Hundreds of millions of feet of centrifugally-cast-iron pressure pipe are now in service. All of this pipe is more uniform in metal structure, in wall thickness, and in concentricity, than pipe not centrifugally cast.

Better production control means better pipe; it results in greater uniformity of quality.

Production controls in cast iron pipe foundries start almost literally from the ground up with inspection, analysis and testing of raw materials; continue with constant control of cupola operation by metal analysis; and end with rigid tests of the finished product.

By metallurgical controls and tests of materials, our members are able to produce cast iron pipe with exact knowledge of the physical characteristics of the iron before it is poured into the mold of a centrifugal casting machine.

Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction.

Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Avenue, Chicago, 3, Illinois.

Section of 114-year-old cast iron gas main still in service in Baltimore, Md.

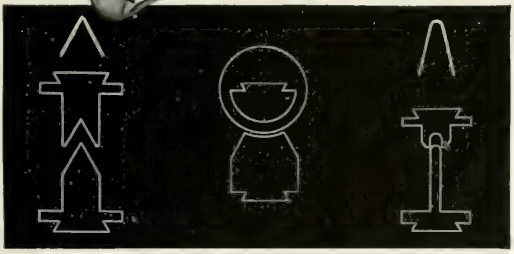
CAST IRON PIPE SERVES FOR CENTURIES

What's Happening at CRUCIBLE

about scoring and cutting rule steel

Lengths of cutting rule steel after edging

Shaped to cut wallet section (note bends, and form-holding method)



Some examples of the many shapes of bends needed

Scoring and cutting rule steel is a cold-rolled specialty steel for use in preparing dies for cutting paper, leather, rubber and other materials.

It is a pre-tempered product manufactured by skilled workmen, using precision rolling and hardening equipment, to close limits for chemistry, grain size and hardness. This product must also be capable of meeting intricate bend requirements in the hardened and tempered condition.

This specialty is furnished with round edges and in coil form to the rule manufacturer who grinds the edges — the one edge square and the other to a knife edge as well as cutting the material into desired lengths. This is sold to a die-maker who bends the rule to the required shape. This is then the nucleus of a pre-hardened die, which when properly brazed and supported is used to cut out material for display cards — aircraft parts — pocketbooks — wallets — gloves — gaskets — washers.

engineering service available

Since there is a great diversity of cold-rolled products, our staff of field metallurgists can help you apply what you require. Take full advantage of Crucible's more than 50 years experience as the first name in special purpose steels. Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

52 years of Fine steelmaking

Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

AERIAL PHOTO . . .

(*Continued from page 26*)

Stereo photos were then taken at each location, the two pictures overlapping 55 percent or more. The aerial mapping company's field survey crews next established the elevation and the distance between four fixed datum points, for each location photographed, to serve as ground controls. Permanent points were selected which would serve as a ground control to be used in subsequent surveys.

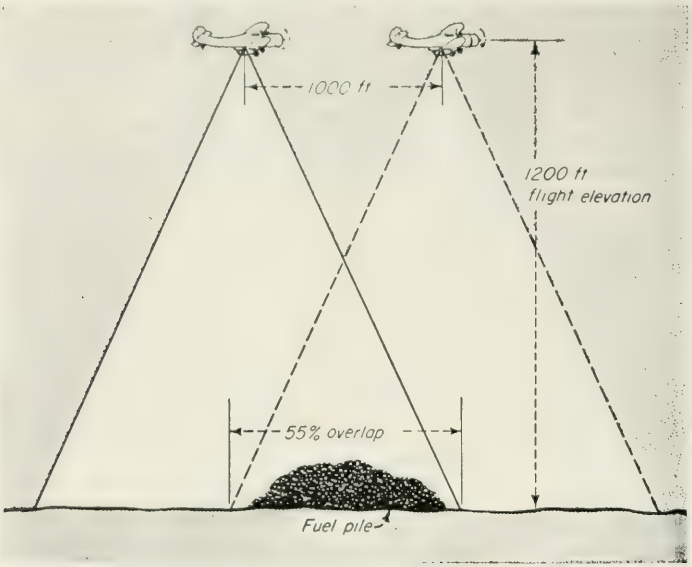
Using these ground datum points as the basis for height and distance measurements, the aerial photographs were studied through stereo-plotting machines. These precise instruments made use of a stereoscopic principle to obtain a three-dimensional image of the coal pile from which topographic maps of each coal pile can be constructed—in this case—to a scale of 1 inch equals 40 feet with a 1 foot contour interval. Spot elevations were read to within 0.2 ft. on breaks and flat areas. Using the 1 ft. contour lines of the various pile levels the area of the layer represented by each contour was measured woth a polar planimeter. Volume of each pile was computed from the data thus obtained. Aero Service Corp engineers point out that any error in computations of a particular segment or layer of the stockpile was self-corrected as the computations went from peak to base. Maximum error was 3 to 5 percent or less for an entire pile.

With the volume figures at hand, Philadelphia Electric Co. established the tonnage for each stockpile. To do this several coal samples were taken at each stockpile to determine the average weight of a single cubic foot of coal, thus enabling the volume of each stockpile to be readily translated into different grades and weights. Smaller piles of coke and anthracite coal used in gas manufacturing were included in the survey.

Costs of the air survey depend on the size and number of stockpiles and the location of airport facilities. Probably a considerable economy would prevail even for air inventories of only a few stockpiles. Certainly the benefits of speed and accuracy of the aerial method would prevail.

Several other important uses of aerial photogrammetry which are now in the process of development are:

1. Profiling for transmission lines.
2. Reservoir studies for hydroelectric power developments.
3. Plant construction maps.
4. Records and public relations purposes.



Stereo photos that overlapped 55 per cent or more were made at each stockpile site from 1200 feet. The plane travels about 1000 feet between pictures, giving large third dimension effect. The aerial crews next established the elevation and distance between fixed datum points for each location photographed to serve as ground controls.

SKIMMING . . .

(*Continued from page 16*)

Westinghouse. As a by-product of research aimed at improving lamp starting, he devised a small lamp that emitted about three times more ozone-producing ultraviolet than the previous lamp. Then, all that was needed to make the new lamp was to select a glass bulb capable of transmitting more of the ultraviolet frequencies.

The new lamp eliminates unpleasant odors more efficiently and quickly than the old lamp. A 3½ watt, 12 volt bulb. it will last six months when operated 24 hours a day. It can be operated from a standard 110-volt, single-phase, a-c source by using a special fixture containing a built-in transformer to limit the current and voltage.

semi-conductors

Materials known as semi-conductors, which can be used to amplify weak electrical currents and which may replace many of the vacuum tubes in radio receivers, were described recently by Dr. Hebb, of the GE Research Lab.

He said that the importance of semi-conductors lies in the fact that they do not behave like ordinary electrical conductors, such as copper and other metals. With the latter materials, the current that passes through is proportional to the voltage applied. Semi-conductors do not follow this law. They can be arranged to conduct current well in one direction and poorly in the opposite direction. In other arrangements, the current conducted can be increased by increasing the light falling on the unit, or by a second and smaller current, entering through another wire.

Dr. C. G. Suits, GE vice president and director of research, cited as two other advances new developments in curious elements known as semi-conductors which may cause many types of electron tubes to be replaced by a much simpler device, and studies which are giving science new knowledge as to why metals and alloys behave as they do.

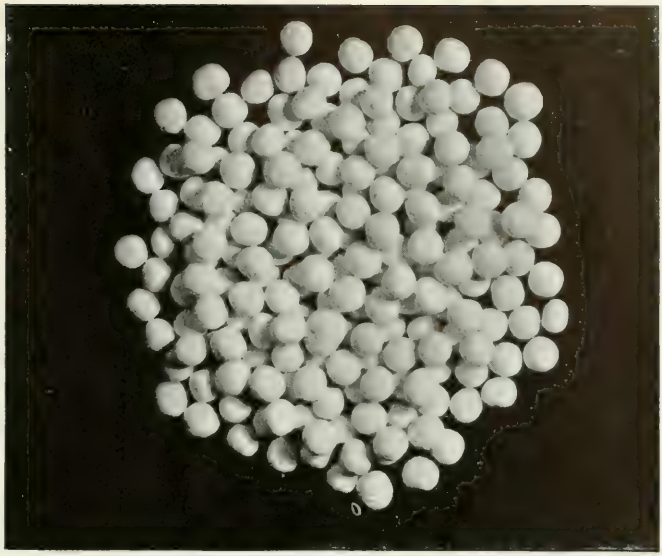
The GE official said the new source of lighting is accomplished with an effect known as "electroluminescence," which was discovered in 1936 by a Frenchman named Destriau. He explained that this can be accomplished with a piece of glass coated with a transparent but electrically-conducting film, over which is placed a layer of a powdered "phosphor," like that which gives the light in a fluorescent lamp.

On top of this is placed a metallic film, making a sandwich of phosphor between two conducting layers. When these are connected to an electric current, the phosphor glows with cold light,

(*Continued on page 44*)

What Are These Spheres?

- ☐ *Catalyst Supports*
- ☐ *Moth Balls*
- ☐ *Abrasive Grains*



They are catalyst supports — Norton refractory products made of chemically inert, heat-resistant, wear-resistant materials for use as catalytic carriers in chemical processes. Pictured in spherical shape here, they are also available as pellets and rings.

Composition and Properties

These supports are commercially available in ALUNDUM* (fused alpha alumina) mixtures varying from 77% to 89% alumina with silica as the principal impurity. In addition to their refractoriness, they are chemically inert, mechanically strong and wear-resistant

Water absorption values of these supports vary from 12% to 22% by weight. Surface areas by the nitrogen absorption method range up to about one square meter per gram. Crushing strengths vary from 20 to 600 pounds, depending on size and shape, and bulk densities range from 60 to 80 pounds per cubic foot.

Many Refractory Products

Catalyst supports are but one of many refractory products made by Norton. These include small furnace refractories such as tubes, cores and muffles; large furnace refractories such as bricks, plates, muffles and other shapes; refractory cements; refractory laboratory ware; kiln furniture for ceramic plants.

In its search for refractory products that can be used at higher and higher temperatures, Norton has developed a line of pure oxide refractories. These refractory shapes, as their name implies, are molded without bond and then fired at sufficiently high temperatures to produce a truly sintered product.

The principal raw materials used in the manufacture of Norton pure oxide refractories are ALUNDUM (fused alumina), MAGNORITE* (fused magnesia), fused stabilized ZIRCONIA and, to a limited degree, fused thoria.

Planning Your Future?

Norton Research is continually developing better products to make other products better. Young technicians who are interested in contributing to the technical advances of the future will find Norton Research well worth investigating.

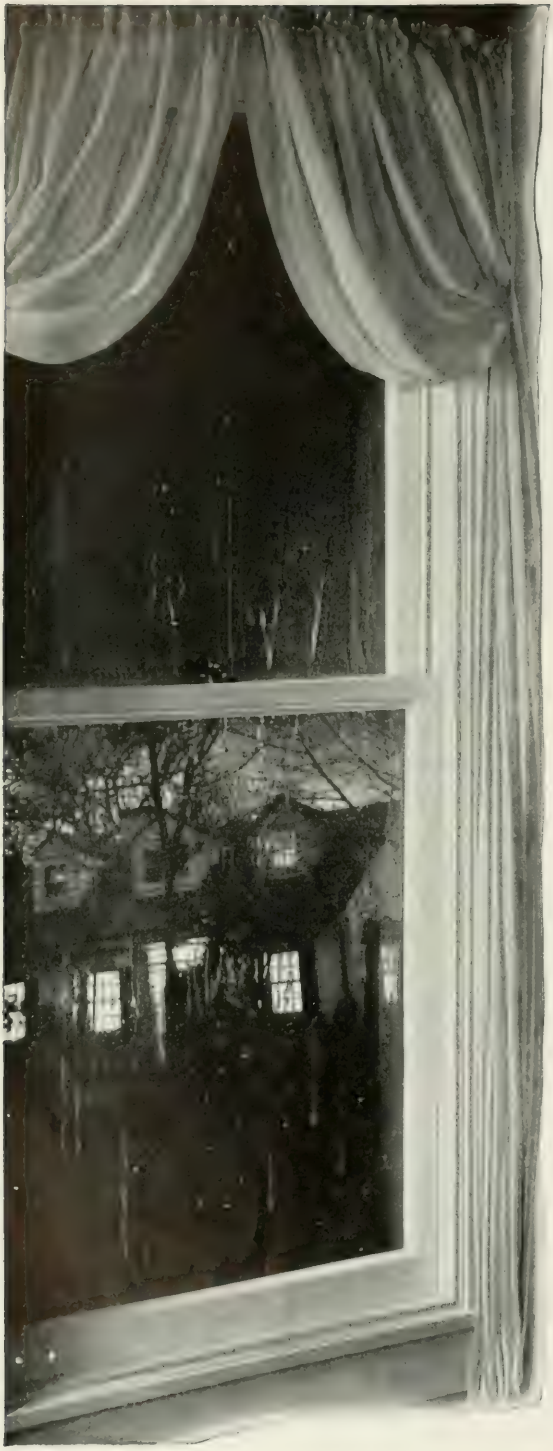
Free Booklet on

longer lasting Norton refractory products contains detailed descriptions of Norton contributions in this field. Write for your copy.

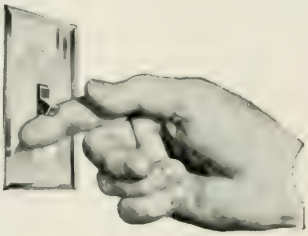
Norma L. Gullberg, A.B., Chemistry, Clark University '46, takes a reading with an optical pyrometer on a high temperature furnace used for catalyst support tests.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

NORTON
TRADE MARK REG U S PAT OFF
Making better products to make other products better
ABRASIVES · GRINDING WHEELS · OILSTONES · ABRASIVE PAPER & CLOTH
REFRACTORIES, POROUS MEDIUMS & LABORATORY WARE · NON-SLIP FLOORING
GRINDING & LAPPING MACHINES · BORON CARBIDE PRODUCTS
NORTON COMPANY, WORCESTER 6, MASSACHUSETTS
BEHR MANNING TROY N Y IS A DIVISION OF NORTON COMPANY



Gloom chaser . . . that works

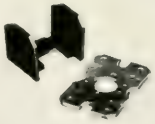


Fair weather or foul, when you flip a light switch you *expect* light. You take it for granted. Actually, like a touchdown in football, the result is the triumph of teamwork in electrical apparatus.

The power company is the captain. The players include the manufacturers of generators, transformers, switch gear, and electrical fixtures. But an *unseen essential* called *Synthane* is present, too.

Synthane is a laminated plastic. It is an excellent electrical insulator. It is also a mechanical material that combines light weight and strength, a chemical-resistant material that machines easily.

Send for the complete Synthane Catalog. Then, if you find Synthane a material you can use, we will be glad to help you with design, sheets, rods, tubes or fabricated parts. Synthane Corporation, 10 River Road, Oaks, Pennsylvania.



Insulator (left) made from Grade X Black Synthane for Square D Company and switch mounting plate made for Cutler-Hammer Inc. of Grade GLCC-M Synthane. Both parts require good electrical characteristics.

Synthane-one of industry's unseen essentials

SYNTHANE

LAMINATED PLASTICS

New RCA Victor record changer
—easiest to play at all three speeds!

THE CENTER IS THE SECRET:
Just slip on the large center spindle to play "45" records *automatically*. Slip it off, and play records at other speeds.
Permanent spindle and changer play stacks of 33⅓ or 78 rpm records automatically.
A flick of the finger and you have the right needle to play 45, 33⅓, or 78 rpm records.
Fingertip control of speeds (78, 33⅓, 45) and one control for *On*, *Off*, or *Reject*.

World's simplest 3-speed changer, this versatile Victrola combines new playing ease with the finest reproduction of sound. And it changes "45" rpm records *correctly*, on the same turntable used for other speeds.

Key to this advance is RCA Victor's *slip-on* "45" spindle, which fits over the permanent spindle and locks in place. No plugs or extra gadgets. Simply stack your "45" records on this fine instrument, and play up to fourteen of them—at the twist of a knob. Then, whenever you wish, remove the "45" spindle, flick the needle and speed controls, and the same Victrola changer will play records automatically at 33⅓ or 78 rpm.

More than a year of research and engineering went into this changer—further evidence of the leadership which assures you finer performance in any product or service of RCA and RCA Victor.

* * *

See the latest in radio, television, electronics at RCA Exhibition Hall, 36 West 49th St., N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y. Trnks. ®

RADIO CORPORATION OF AMERICA

World leader in radio—first in television

CONTINUE YOUR EDUCATION WITH PAY—AT RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey. **Also many opportunities for Mechanical and Chemical Engineers and Physicists.**

C. E. DEPARTMENT . . .

(Continued from page 12)

This course lays the ground work for the soil courses that are to follow. Analytical mechanics is the mathematical analysis of force systems and simple trusses when no motion takes place in the systems under consideration.

The civil engineering student in the third year takes the following courses: *1st semester*, soil and bituminous materials (C.E. 230), plain concrete (C.E. 235), structural analysis (C.E. 261), mechanical power equipment (M.E. 201), analytical mechanics (Dynamics), and resistance of materials; *2nd semester*, highways (C.E. 220), structural analysis (C.E. 262), elementary structural design (C.E. 263), fluid mechanics and electives. Soils and bituminous materials deals with these materials as encountered in engineering work and emphasizes their uses and limitations. Plain concrete gives the student a knowledge of how concrete is made, the factors upon which the concrete's strength depends and the design of a concrete mix of desired strength. Structural analysis deals with the analyzation of simple structures to determine stresses in members and maximum safe loads applicable. Mechanical power equipment provides the student with the knowledge of different types of engines and their uses. Analytical mechanics (Dynamics) teaches students to analyze machines in motion. Resistance of materials is a study of the interior stress of a material which is evidenced when the material is loaded. Highways deals with the material used in highway construction (surface and sub-surface). Structural analysis is a continuation of the first course in structure. Elementary structural design deals with the fundamentals of design work in the medias of steel and reinforced concrete. Fluid mechanics is concerned with the problems encountered in the flow of fluids in pipes, channels, nozzles.

In the fourth year the student chooses his option in civil engineering. By choosing an option he chooses a phase of civil engineering in which he wishes to specialize. The options open to students include: general construction, highway, hydraulics, railway, and structural. After the option is chosen the student concentrates on courses pertaining to his chosen option.

In the fall of 1953 the whole engineering curriculum will be changed slightly due to entrance requirements. The entrance requirements will be stepped up so that high school students must have advanced algebra and trigonometry. Thus, mathematics, will be shortened by one semester, permitting three semesters of physics. The added change in the civil engineering is that summer camp will be given between the second and third years.

The civil engineering department does not turn out complete civil engineers, for no matter how long a man is in a profession he can never achieve complete knowledge of it. Each day something new is learned. Civil engineering teaches the man to reason and think, utilizing the knowledge derived from his college education as a basis for expansion of his capacity. With such a formidable weapon any problem can be solved.

Students are like blotters, they absorb what the instructor says, but get it backwards.

* * *

Freshman: "Why do the janitors here wear uniforms?"

Senior: "So we can tell them from the faculty."

* * *

Newsboy: "Extra! Extra! Read all about it; two men swindled."

Passerby: "Give me one—say there ain't anything about two men being swindled in here."

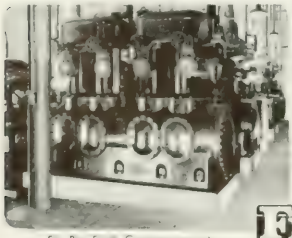
Newsboy: "Extra! Extra! Three men swindled."

Philadelphia's Largest Brewery Uses 2300 Horsepower of

FRICK Refrigeration

C. Schmidt and Sons, Inc., founded in 1860, now make over a million barrels of beer and ale annually in their plant on Edward Street.

A pair of Frick four-cylinder ammonia compressors was installed at Schmidts' twelve years ago. Today this battery includes six machines, the largest with motors of 450 hp. each.



Six Big Frick Compressors at C. Schmidt and Sons' Brewery

For dependability, stick to Frick Refrigeration.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

DEPENDABLE REFRIGERATION SINCE 1853

FRICK & CO.

WAYNESBORO, PENNA., U.S.A.

Also Builders of Power Farming and Sawmill Machinery

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The thousands upon thousands of men who use precision tools will tell you that there are none better than Lufkin. All Lufkin precision tools are the product of years of fine tool-making experience combined with the very latest design features. Experienced engineers know Lufkin tools are the most accurate they can buy. See the complete line of Lufkin tapes, rules, and precision tools at your hardware or tool store.

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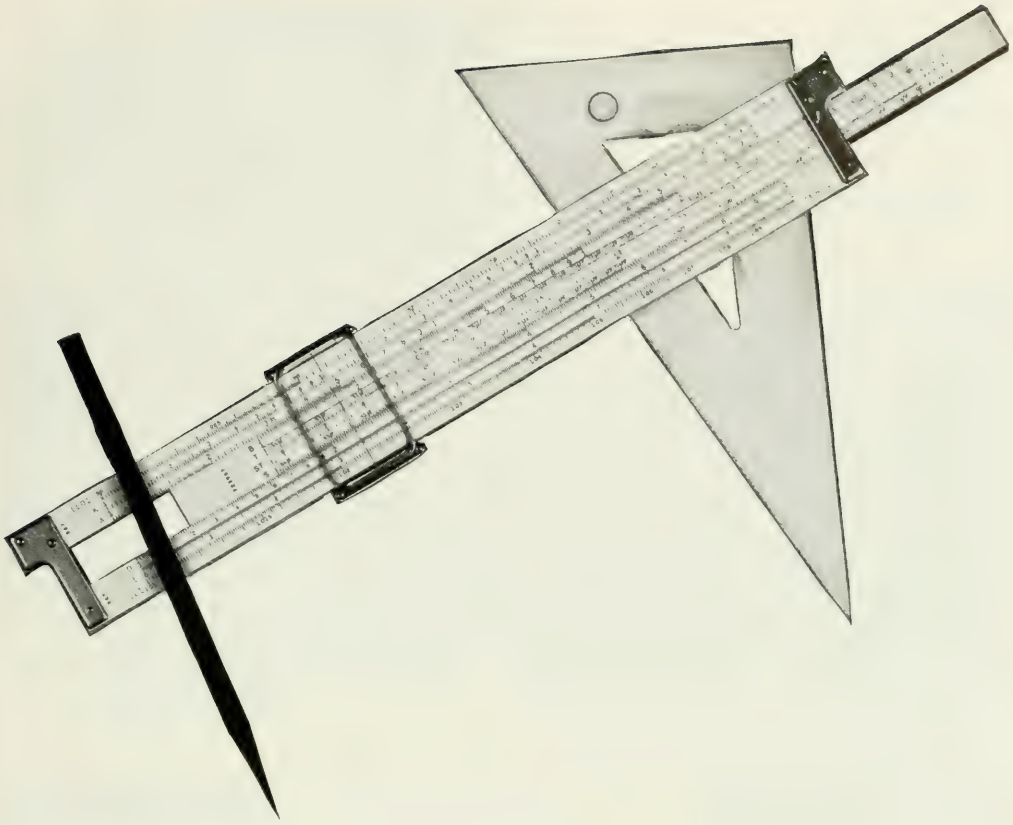


You'll find classmates—and a future—at Boeing!

Men from more than 120 top engineering schools are building rewarding careers at Boeing. So chances are, you'd be working with some of your classmates here. And in addition you'd be a member of an Engineering Division renowned for its trail-blazing contributions to both military and civil aviation.

If that's the kind of engineering prestige you'd like to enjoy, look into Boeing opportunities. This company has been growing steadily for 35 years. It provides the finest research facilities in the industry. It offers you work on such exciting projects as guided missiles and the fastest known bomber in the world: the B-47 six-jet medium bomber, as well as the still-classified B-52 eight-jet heavy bomber.

You can work in Seattle, in the Pacific Northwest, or in Wichita, Kansas. Boeing provides a generous moving and travel allowance, gives you special training, and pays a good salary that grows with you.

Plan *now* to build your career as a member of Boeing's distinguished Engineering personnel after graduation. Boeing has present and future openings for experienced and junior engineers in aircraft

- **DESIGN**
- **RESEARCH**
- **DEVELOPMENT**
- **PRODUCTION**
- **TOOLING**

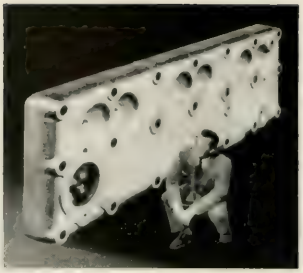
also for servo-mechanism and electronics designers and analysts, and for physicists and mathematicians with advanced degrees.

For further information, consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer — Personnel
Boeing Airplane Company, Seattle 14, Washington

BOEING

Here's where CARBORUNDUM *is going with "man-made minerals"*



CASTINGS ARE IMPROVED in machinability when FERROCARBO, a deoxidizer used in metallurgical processes, is added to the molten metal. This product by CARBORUNDUM is effective in producing the clean castings essential to today's unusual requirements.

Made by the Bonded Products and Grain Division

ROCKET EXHAUST LINERS are among the developments by CARBORUNDUM that take over where ordinary materials are inadequate to the task. Produced from *"man-made minerals,"* this super refractory product is highly resistant to the extremes of abrasion and high temperature produced at the rocket nozzle. Super Refractories have been developed by CARBORUNDUM to increase output and reduce operating costs where high temperatures, resistance to abrasion, corrosion or erosion are important factors.

Made by the Refractories Division

POWDER METALLURGY is a field of interesting new developments. These gears are produced by sintering powdered metal in furnaces equipped with GLOBAR silicon carbide electric heating elements. Having extremely high electrical resistance and no known melting point, the heating elements make it possible to attain high heats under accurate control.

Made by the GLOBAR Division

FURNITURE MAKERS are now using the new extra-hard finishes for increased beauty and durability, aided by RED-I-CUT Waterproof Abrasive Paper developed by CARBORUNDUM. This tough new paper cuts faster, gives a better finish and, as an enthusiastic shop owner expressed it, "more mileage than anything we have ever used."

Produced by the Coated Abrasives Division

Searing flame and erosive gases make life incredibly short for uncooled rocket blast tubes.

Problem without precedent: how to protect the tubes without using costly alloys. Experiment, testing and imaginative thinking resulted in a solution by CARBORUNDUM—molded super refractory liners. Molded, then baked, they must emerge from the oven with tolerances of which a machinist might be proud.

Problems without precedent are the kind we like. In fact our business was born with the invention of a material without precedent, the first "man-made mineral." This was silicon carbide, a product of the electric furnace, which has since become familiar the world over in products by CARBORUNDUM.

Your own concern with "problems without precedent" is the reason why we bring you this message here. Whether you are a potential customer of CARBORUNDUM or a potential member of our great engineering staff, we welcome your interest—and your inquiries.

Look to CARBORUNDUM *for the real news about "man-made minerals"*

TRADE MARK

THE CARBORUNDUM COMPANY, NIAGARA FALLS, N. Y.

Products by CARBORUNDUM include Grinding and Cutting Off Wheels, Discs and Sticks... Coated Abrasive Sheets and Belts... Waterproof Abrasive Paper ... Abrasive Grain and Powders and other abrasive products... Electric Heating Elements and Ceramic Resistors... Grain and Briquettes for deoxidizing steel and iron... Super Refractory Bricks, Special Shapes and Cements... Porous Filter Media and Diffusers—and are marketed under the following trademarks:

CARBORUNDUM · ALOXITE · MX · RED-I-CUT · GLOBAR · FERROCARBO · CARBOFRAX · ALFRAX · MONOFRAX · MULLFRAX

8-182

how thick?

A 52-inch ingot of cast steel. Cut to size with the fire-lance of the oxyacetylene flame knifing through the thickest steel maintaining peak production schedules.

how thin?

The gossamer-sheer of *tres chic* Orlon blouses — from acetylene, a basic ingredient of the newest materials for clothing — insulations — plastics.

at the frontiers of progress you'll find

AN AIR REDUCTION PRODUCT

From a lance of fire — to a lady's clothes. Carbide acetylene is the basic building block of a whole range of today's — and tomorrow's — newest products.

Combined with oxygen, acetylene forms a key to our industrial progress. As metal welding, cutting, and conditioning agents carbide and carbide acetylene add their share to an economy based on high industrial production.

And these are but two of the many products of the Air Reduction Corporate family — products contributing to almost every phase of American life — and progress.

In fact, wherever progress is racing ahead to new frontiers, you will find an *Air Reduction Product*.

AIRCO®

AIR REDUCTION COMPANY, INCORPORATED

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Divisions of Air Reduction Company, Incorporated, AIR REDUCTION SALES COMPANY, AIR REDUCTION PACIFIC COMPANY, AIR REDUCTION MAGNOLIA COMPANY... *Industrial Gases, Welding and Cutting Equipment* • AIRCO EQUIPMENT MANUFACTURING DIVISION • NATIONAL CARBIDE COMPANY... *Calcium Carbide* • OHIO CHEMICAL & SURGICAL EQUIPMENT CO., OHIO CHEMICAL PACIFIC COMPANY... *Medical Gases and Apparatus — Hospital Equipment* • PURE CARBONIC COMPANY ... *Carbonic Gas and "Dry-Ice"* • AIRCO COMPANY INTERNATIONAL... *Export* • AIR REDUCTION CHEMICAL COMPANY... *Tertiary Acetylenic Alcohols and Glycols*

INTRODUCING . . .

(Continued from page 14)

of relief projects in Southern Illinois which would facilitate the development of that region. Out of this study came Crab Orchard Lake, which is the largest lying wholly within the state. He has been chairman of the University Building Program committee since 1937. This group makes recommendations as to what buildings should be built on campus and to their size.

The civil engineering department, which Professor Huntington heads, is one of the nation's finest. It has the largest graduate enrollment of any civil engineering department in the country. One-fortieth of all the Bachelor's degrees in CE, one-twelfth of all the Master's degrees, and one-fourth of all the Doctor's degrees awarded in this country during the post-war years, are from Illinois. A very large portion of the civil engineering textbooks used throughout the country were written at Illinois. The department carries on a very large research program which is well-integrated with the educational program. Of the 104 graduate students, almost half are from foreign countries, ranging all the way from England, Scotland, and Switzerland to Egypt and Thailand. Also, Illinois is one of four or five schools in the country to which the Corps of Engineers sends officers for graduate work in civil engineering and the only school selected by the Army, Navy and Air Force graduate training in structural dynamics.

Professor Huntington has written

PROF. W. C. HUNTINGTON

two books. One, Building Construction, is a familiar text to most CE students. The other which is on Earth Pressures and Retaining Walls, is just nearing completion. For his vacations, Professor Huntington likes to go to his cabin in the Colorado mountains.

NAVY PIER . . .

(Continued from page 15)

The program for this semester is well planned and promises to be even better than the previous semester's interesting lecture series.

ENGINEERING COUNCIL

The department of engineering was treated to a smoker, sponsored by the Engineering Council. At the smoker Gloria Winkel and Melvin Beckman's names were inscribed on the scholarship bell. Melvin Beckman was editor of this column last semester.

INSTITUTE OF AERONAUTICAL SCIENCES

A preliminary meeting was held in May and a committee was chosen to write up the constitution for this proposed society. The future of this new society seems assured by the large attendance at the first meeting.

PHYSICS CLUB

Elections were held May 15 and the following people were elected to office.

Bruce Burgess — President
Donald Byrkit — Vice President
John Kaminsky — Secretary-treasurer

Incidentally, Bruce Burgess is the new Navy Pier Editor for the *Technograph*.

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SKF INDUSTRIES, INC., Philadelphia 32, Pa. — manufacturers of SKF and HESS-BRIGHT bearings.

SKF BALL AND ROLLER BEARINGS

THE DU PONT DIGEST

This powerhouse *for a nylon plant at Martinsville, Va., was designed by Du Pont engineers. It houses two 135,000 lb./hr. boilers and two 7,500 KW extraction turbine generators.*

Power Work for M.E.'s

Varied needs of 71 Du Pont plants pose a host of original power problems

Heart of Du Pont's manufacturing program is the power plant. To make some 1200 products and product lines the Company operates 71 plants.

Most require steam and electric generation, water supply and treatment, heat exchangers, piping systems and related services. The designing of these power plants, their erection and operation are all in the hands of engineers, the great majority being mechanical engineers.

But this is not the most interesting thing about power work here. What challenges the highest skills of the engineer at Du Pont is the wealth of original problems constantly arising. Power requirements vary enormously, not only from plant to plant but from time to time.

Process operating pressures may range from over 15,000 psi. to 2 mm of mercury, electrical requirements from as low as 7,000 to higher than 1 million KWH/day, and temperatures from −360° to over 3,500°F.

George S. Mahaffey, *B.S. in M.E., Penn State '52 (right), B. S. Norling, B.S. in E.E., Washington State '24, and A. S. Noell, Jr., B.S. in E.E., Duke '51, discuss the power requirements of a new processing area.*

Here are examples of recent "off-the-beaten-path" power problems.

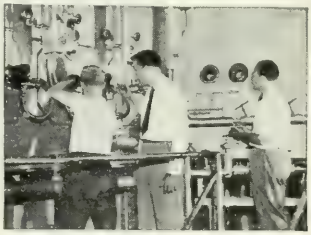
1. A plant using natural gas as its basic fuel produces a waste oil of variable hydrocarbon composition and a waste gas with only 110 Btu/cu. ft. Du Pont M.E.'s designed burners, fans, boilers and combustion controls to permit use of all three fuels for generating steam.

2. At another plant 20,000 gpm of cooling water were to be drawn from a nearby river. Since the water level fluctuated 40 feet between normal and flood stages, it was necessary to evaluate several plans for pump-house constructions against cooling towers. The engineers installed a unique pump house whose submerged vertical pumps operate even when the structure is entirely under water.

Aside from design and construction, Du Pont mechanical engineers concern themselves with such related subjects as economic evaluations, equipment selection, heat balances, load calculations, waste heat boilers.

For example, where various process temperatures from 300° to 600°F. were required, Dowtherm was selected as the supply medium at the rate of 35 million Btu/hr. The engineers installed a central system for primary supply because it calculated to be more economical than separately located vaporizers.

On the operational side, M.E.'s supervise the supply of power and services. They establish performance standards and analyze equipment for results, cost and maintenance.



Edward W. Garrison *(right) M.S. in M.E., California Tech '47, and Byron R. Brown (center), B.S. in M.E., New Hampshire '49, supervise adjustment of furnace conditions in a study of power-plant efficiency.*

Whether viewed from the design and construction side or the operational side, the diversity of Du Pont's manufacture offers a wealth of opportunities in power work for the mechanical engineer.

OPPORTUNITIES for men and women with many types of technical training are discussed fully in "The Du Pont Company and the College Graduate." For a copy, write 2521 Nemours, Wilmington, Del.

DU PONT

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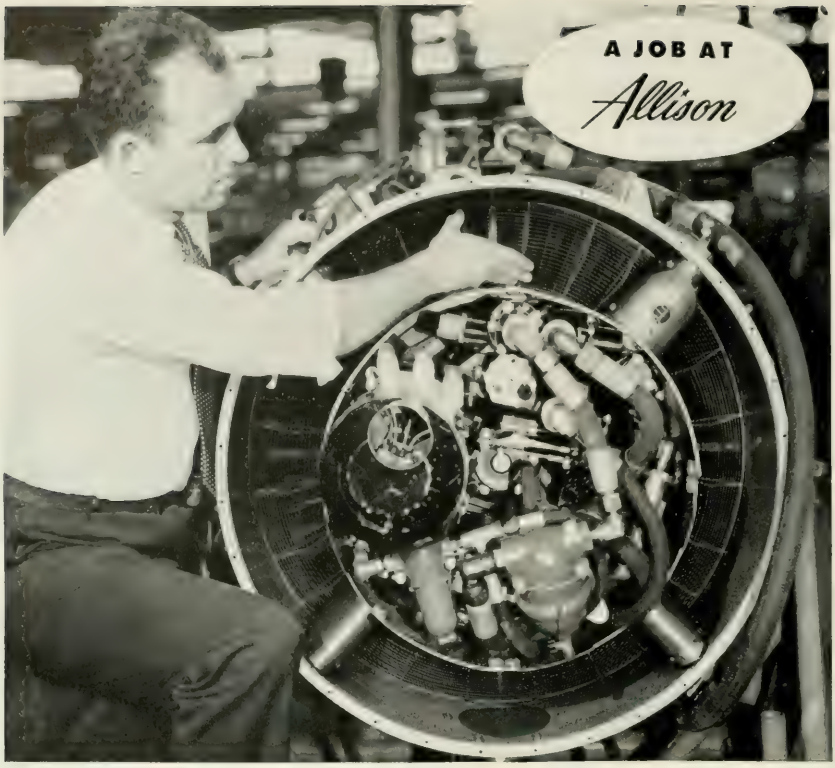

● F. E. Haynes, who received his BS degree in Mechanical Engineering in 1948 from Tri State College, Angola, Indiana, has an important engineering assignment at Allison. He is working on the development of anti-icing systems for jet and turbo-prop engines.

This involves, among other things, a sensing device which will detect ice formation and set off automatically a de-icing system. The air inlet screen is a critical part of a jet engine in the formation of ice. These screens serve a necessary purpose in warding off foreign objects—such as stones, birds or cartridge cases—which if admitted into the air stream will do serious damage to the engine. On the other hand—even on a summer day—an airplane may encounter at altitude an atmospheric condition which, in a matter of seconds, will form ice on the one-quarter inch screens. When this happens, the supply of air to the engine is shut off, temperatures soar out of limits and critical engine parts actually "burn up" with complete failure of the engine.

Solution of this problem is a real challenge to the engineering profession. Haynes is only one of many young engineers at Allison who, by working on this and other problems, is making a real contribution to the science of jet engine design. At the same time they are adding importantly to their own knowledge of a subject which offers life-time careers for professional engineers.

Allison is looking for young men with degrees in

MECHANICAL ENGINEERING ELECTRICAL ENGINEERING AERONAUTICAL ENGINEERING

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For further information about YOUR engineering career at ALLISON, discuss it with your Placement Counselor and arrange for an early interview with the ALLISON representative the next time he visits your campus. Or, write now for further information: R. G. Greenwood, Engineering College Contact, Allison Division, General Motors Corporation, Indianapolis 6, Indiana.

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How chemical research in petroleum yielded benefits far a-field

ONE OF THE processes on which Standard Oil has done important development work is the Oxo process, which converts olefins to aldehydes and alcohols by high-pressure reaction with a mixture of hydrogen and carbon monoxide.

Today Standard Oil is constructing an Oxo plant for the large-scale production of iso-octyl alcohol. Its capacity will be ten million pounds a year. Other alcohols could be produced here with only minor changes.

Iso-octyl alcohol is used to make phthalic and adipic esters. These are plasticizers for vinyl plastics, found in a wide variety of products ranging from toys to life rafts. Iso-octyl alcohol is also useful as a base for making lube additives, anti-foam agents, and other important products.

Research on the Oxo process continues in our Whiting laboratories with a view toward improving plant operation and finding other applications for the process.

The Oxo process is just one of a wide variety of subjects under study at Whiting by young men with training in engineering and chemistry.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

SKIMMING . . .

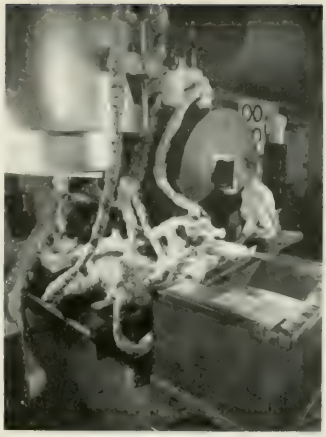
(Continued from page 32)

rather than the type of light from the white-hot filament of the incandescent lamp.

At present, he stated, this kind of lighting is not efficient, but it is being actively studied. Two GE scientists recently reported that single crystals of the phosphor may be made to glow, yielding many times as much light as with the powder. This, he said, seems one possible way of improving the output of light from this source.

Semi-conductors, he said, are elements which lie midway between familiar metals, such as copper, which conduct electricity, and insulators. Germanium is one of the most important of semi-conductors and is finding applications in many tasks where complicated vacuum tubes were formerly employed.

A germanium unit called a diode can be used as a rectifier, to turn alternating current into direct current, Dr. Suits said. Another unit slightly more complicated but still much smaller than the tube, is the transistor, which can amplify weak currents. One advantage of the transistor over tubes, he continued, is that it will operate on minute amounts of power. The vacuum tube amplifier, by contrast, must be supplied with relatively large amounts of power, comparable to using a ten-ton truck to deliver a needle, Dr. Suits said.



Low temperature testing of new jet fuel pumps. (Courtesy of Westinghouse.)

"For the first time," he said, "we are beginning to understand the practical engineering properties of metals and alloys, such as their tensile strength, in terms of the basic properties of atoms and molecules." Studies have revealed the importance of tiny nuclei as starting points for processes that occur in metals. Such nuclei may be either some foreign material or defects in the crystalline arrangement of the atoms.

"It may seem surprising," he said, "that many properities of metals important to engineers are being determined by microscopic studies of atomic defects in the crystals of which these metals are made."

Cold Light Illumination

A new source of illumination by which materials are made to glow with cold light when an electric current passes through them was listed among a number of important recent advances in scientific research by a GE official recently.

Cold Test for Jet Accessories

New fuel pumps for use on jet planes are now being tested at the low temperatures which they will encounter at high altitudes. Jet engine accessories must function at temperatures as low as 67 degrees below zero, and each new design is subjected to cold tests in this cylindrical chamber. The fuel tank containing the alcohol that is circulated through the fuel pump is cooled with powdered dry ice. Fuel lines are insulated with aluminum foil that is pressed in place by hand, permitting quick and simple changes in the test set-up.

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Write for illustrated bulletin on the new No. 4 Automatic. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

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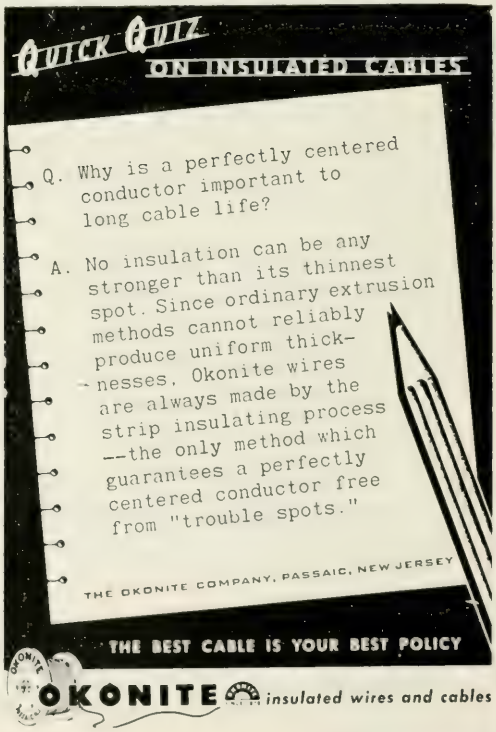
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Q. Why is a perfectly centered conductor important to long cable life?
A. No insulation can be any stronger than its thinnest spot. Since ordinary extrusion methods cannot reliably produce uniform thicknesses, Okonite wires are always made by the strip insulating process --the only method which guarantees a perfectly centered conductor free from "trouble spots."
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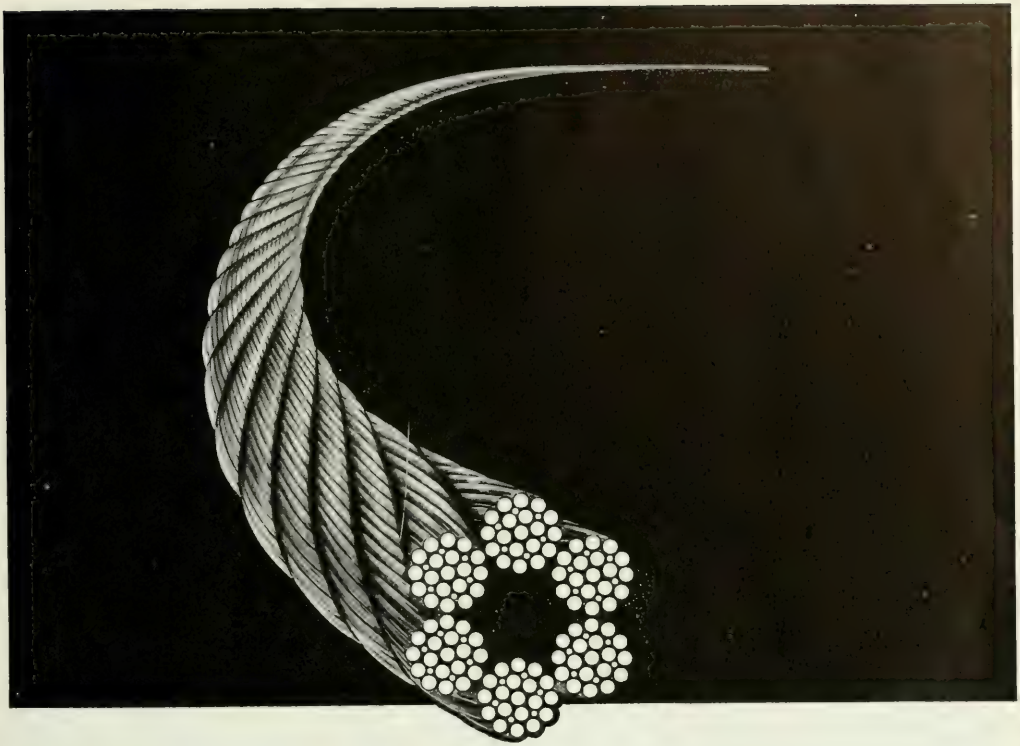

HOW MANY FEET TO A FOOT...

A one-foot length of this six-strand, steel-sinewed piece of wire rope has 150 or more feet of wire. And each wire in this precision product must be accurate within a thousandth of an inch.

It wasn't always so. But deeper mines and oil wells, higher buildings, greater logging, shipbuilding and construction projects called for stronger, safer rope . . . without increase in diameter. So rope engineering became a science.

SINEW OF INDUSTRY...

Special steels with the right combination of fatigue and abrasion resistance . . . skillful wire drawing . . . lubricant-saturated fiber centers . . . and scores of sizes, grades and "constructions" are necessary to meet today's wire rope requirements.

Wire rope manufacture represents the contributions of countless craftsmen whose challenge was industry's need . . . whose accomplishments, industry's gain.

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To a few engineering graduates, "McGraw-Hill" will mean "writing" as well as "reading."

Spurred by experience on college magazines, or broadened by work in industry, these men will join those of earlier classes who are now McGraw-Hill engineering editors.

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HEADQUARTERS FOR BUSINESS INFORMATION

McGRAW-HILL FOR BUSINESS

Takes a lot to lay a carpet in the jungle

The scene is "darkest Africa".

But Africa is lightening. Man's quest for minerals, for new areas for agriculture and trade, is slashing ultra-modern, glaring-white air strips in once impenetrable jungle.

Those pavers, portable air compressors, pumps and air tools—such as you might see working a city street—are Worthington Blue Brutes going to "lay a carpet" in that hole in the jungle.

Thus, Worthington, a major producer of equipment for public works, industry and farm, brings the fruits of American technical genius to the strange places of the world.

And illustrates, too, how the unique American talent of *diversification* helps public, employees and stockholders. For Worthington makes many things—not just construction equipment and pumps, but also engines, water works machinery, power transmission, petroleum equipment, air conditioning and refrigeration, many others.

Such diversification builds *stability* . . . makes Worthington, 112 years old, a strong link in the chain of American business.

Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Harrison, New Jersey.

WORTHINGTON

The Sign of Value
Around the World

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Good Water and Sanitation—engines pumps · water treatment · comminutors air compressors · air tools

Lower-Cost Manufacturing—pumps compressors · steam turbines · motors power transmission · air conditioning

Petroleum Products—compressors engines · pumps · chilling equipment refrigeration · decoking systems

More Abundant Food—compressors fertilizer mixers · air conditioning refrigeration · pumps

Can you see your future through this Window?

This is an aluminum window, one of four million that will go into buildings in 1953. Twenty years ago, it was just an idea in the mind of an Alcoa development engineer. Ten years ago, only a few thousand were made annually. Now, production *is increasing* at the rate of over half a million a year. This is just one of a torrent of new uses for aluminum which means that Alcoa must continue to expand. Consider the opportunities for you if you choose to grow with us.

What can this mean as a career for you?

This is a production chart . . . shows the millions of pounds of aluminum produced by Alcoa each year between 1935 and 1951. Good men did good work to create this record. You can work with these same men, learn from them and qualify yourself for continually developing opportunities. And that production curve—is still rising, we're still expanding, and opportunities for young men joining us now are almost limitless.

Ever-expanding Alcoa needs engineers, metallurgists, and technically minded "laymen" for production, research and sales positions. If you graduate soon, if you want to be with a dynamic company that's "going places", get in touch with us. Benefits are many, stability is a matter of proud record, *opportunities are unlimited.*

For more facts, consult your Placement Director.

The best things in aluminum come first in

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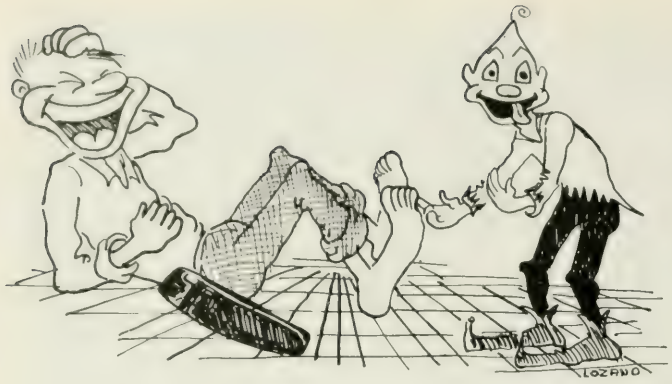
By ALUMINUM COMPANY OF AMERICA • Pittsburgh, Pennsylvania



TECHNOCRACKS

edited by Pete Cattapan, Gen. E. '53

The car stopped suddenly in a dark country lane. "Out of gas," our hero said. The girl friend pulled a flask out of her handbag. "Wow," said he, "Whats' that? Bourbon?" "No," she retorted, "gasoline."

* * *

"Down where I live" boasted the Texan, "we grew a pumpkin so big that when we cut it my wife used one half of it for a cradle." "Well," said the man from New York, "that's nothing. A few days ago, right here, two full-grown policemen were found asleep on the same beat."

* * *

Some girls complained to the dean of women that the boys in the fraternity house next door never closed their blind and that it embarrassed the girls.

When the dean went to the room of the particular girl who had made the complaint, she looked out the window and said, "Why can't I see the window from here?"

The girl said: "Oh, you have to stand on this chair."

* * *

A little boy awakened at 4 a. m. asked his mom to tell him a story. "Just be patient, dear," she said. "Daddy will be home soon, and we'll hear a honey."

* * *

Judge: "Why did you strike your wife?"

Husband: "Well, your honor, she had her back to me, the broom was handy, and the back door was open, so I thought I'd risk it."

* * *

"What happened to your finger?"

"Oh, I was downtown getting some cigarettes yesterday and some clumsy fool stepped on my hand."

They were talking about the difference between men and women. "Now take letter writing, for instance," he said. "You women can never write a letter without a P.S.

"Don't be ridiculous," she scoffed right back.

"I'll write you next week and let you see."

The letter came as promised, and at the end of it was written: "P.S. What did I tell you?"

* * *

A sweet old lady, always eager to help the needy, spied a particularly sad looking old man standing on a street corner. She walked over to him, pressed a dollar bill into his hand and said, "Chin up."

The next day, on the same street corner, the sad old man shuffled up to the lady and slipped ten dollars into her hand.

"Nice picking," he said in a low voice. "Paid ten to one."

* * *

Visitor: "Can you tell me the name of this school?"

Soph: "Sorry, I'm just a football player here."

* * *

"I wonder what's the matter with our Star basketball player—he looks so unhappy."

"It's because his father is always writing him for money."

* * *

Wife: The new maid has just burnt the bacon and eggs, darling. Would you be satisfied with a couple of kisses for breakfast?

Husband: Sure, bring her in.

Walking with a friend one day ,a professor passed a large fish shop where a fine catch of codfish with mouths open and eyes staring were arranged in a row. The professor suddenly stopped, looked at them and, clutching his friend by the arm, exclaimed: "Heavens! That reminds me I have a class in CE this hour."

* * *

The suspicious mistress called her maid in. "Anna," she asked, "If you had the opportunity to go out with one of my sons, which one would you prefer?" "Well, ma'am," said Anna thoughtfully, "that's hard to say. I've had some grand times with both your boys, but for a swell evening, give me your husband anytime.

* * *

A farmer was phoning a veterinarian. "Say, Doc," he said, "I've got a sick cat. He just lays around licking his paws and doesn't have any appetite. What shall I do for him?"

"Give him a pint of castor oil," said the vet.

Somewhat dubious, the farmer forced the cat to take a pint of castor oil. A couple of days later he met the vet in town.

"How's the sick calf?" inquired the vet.

"Sick calf! That was a sick cat I had."

"Did you give him the pint of castor oil?"

"Sure did."

"Well, what did he do?" asked the vet.

"Last time I seen him," said the farmer, "he was going over the hill with five other cats. Two were digging, two were covering up, and one was scouting for new territory."

* * *

Around a hunter's campfire in Tennessee, and old guide was regaling the group with stories.

"I ain't impressed with any of these tales abobut people hittin' game from a triflin' 300 or 400 yards. Lemme tell you about the day I was moochin' along a mountain trail when these here telescopic eyes of mine spotted a buck. I rammed a charge down the barrel of my gun, then some waddin' and a couple of ounces of rock salt. I shoved a bullet down on top of that. Then I let go! Bang—and the buck dropped in its tracks.

One of the men around the fire asker, "What in thunder was the idea of putting salt in your gun?"

"Shucks," the guide replied, "that deer was so fur off that I had to do somethin' to keep the meat from spoilin' before I could get there."

illinois technograph

.25

november, 1952

To keep steel strip on the straight and narrow → → → →

. . . at 1000 feet per minute!

● Threading its way through a gigantic continuous-annealing furnace at speeds up to 1000 feet per minute, steel strip behaves erratically. It tends to wander and weave. It fouls the rolls. Sometimes it breaks. Then production on a multi-million-dollar unit, designed for high-speed operation, slows down or stops dead . . . a very costly business.

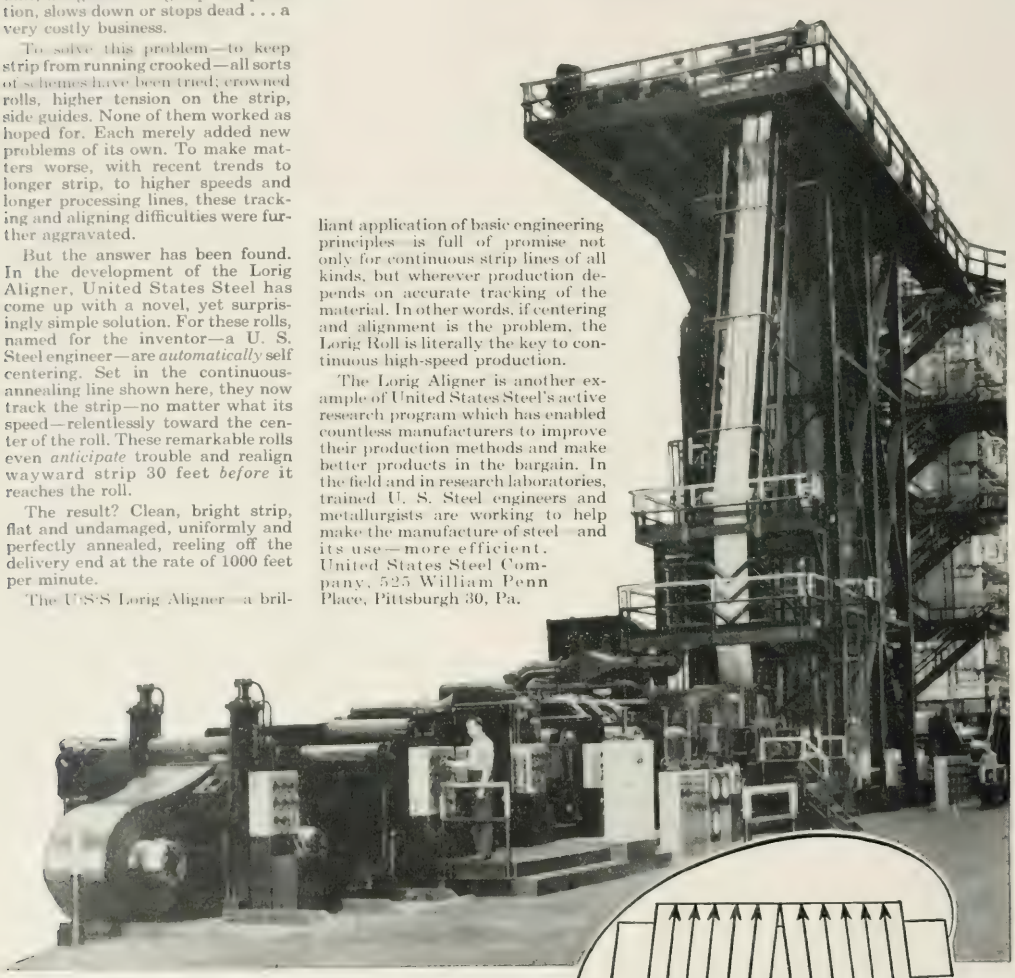
To solve this problem—to keep strip from running crooked—all sorts of schemes have been tried; crowned rolls, higher tension on the strip, side guides. None of them worked as hoped for. Each merely added new problems of its own. To make matters worse, with recent trends to longer strip, to higher speeds and longer processing lines, these tracking and aligning difficulties were further aggravated.

But the answer has been found. In the development of the Lorig Aligner, United States Steel has come up with a novel, yet surprisingly simple solution. For these rolls, named for the inventor—a U. S. Steel engineer—are *automatically* self centering. Set in the continuous-annealing line shown here, they now track the strip—no matter what its speed—relentlessly toward the center of the roll. These remarkable rolls even *anticipate* trouble and realign wayward strip 30 feet *before* it reaches the roll.

The result? Clean, bright strip, flat and undamaged, uniformly and perfectly annealed, reeling off the delivery end at the rate of 1000 feet per minute.

The USS Lorig Aligner—a brilliant application of basic engineering principles—is full of promise not only for continuous strip lines of all kinds, but wherever production depends on accurate tracking of the material. In other words, if centering and alignment is the problem, the Lorig Roll is literally the key to continuous high-speed production.

The Lorig Aligner is another example of United States Steel's active research program which has enabled countless manufacturers to improve their production methods and make better products in the bargain. In the field and in research laboratories, trained U. S. Steel engineers and metallurgists are working to help make the manufacture of steel—and its use—more efficient. United States Steel Company, 525 William Penn Place, Pittsburgh 30, Pa.



THE U.S.S LORIG ALIGNER consists of a divided roll conical effect exaggerated at the center. Each conical half running on a common rotating axle that is [illegible] to the center so that the upper surfaces of the cones form a straight surface. As the strip passes over the roll, strongly converging lateral forces are set up to exert a powerful centering action on the strip that immediately corrects any deviation and keeps the strip running straight and true.

USS TRADE MARK

UNITED STATES STEEL

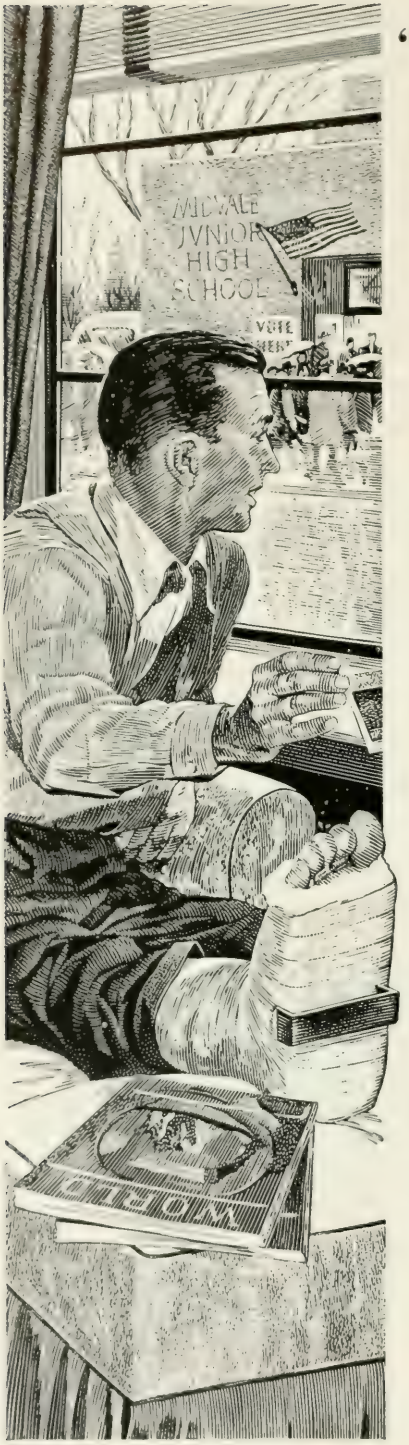
Pursuit of the Almighty A

Psychologists often talk about the basic human drives such as love, fear, and hunger. On this campus, I am afraid, we have another basic drive to add to the list. That drive might be called the pursuit of the almighty **A**. Seemingly, for many people the sole motivation in studying is not to learn something, but merely to get that grade.

Naturally, grades are important. There must be a system by which the quality of work a college student does can be rated. And yet, most of you have taken courses that you squeaked through to get an easy **A** or **B**, but which you can remember hardly anything about now. On the other hand, remember that course you worked hard to get a **C** in, but which you came out of feeling that you had really learned something. Not only in courses such as these, but also in all courses to a certain extent grades tend to become an end in themselves, while the real business of learning is forced to take a back seat.

Many people have the idea that if they manage to get a good grade in a subject, then naturally they have a good knowledge of that subject. Actually, this is putting the cart before the horse. Real knowledge does not necessarily go hand in hand with good grades. But study guided by the purpose of really learning the fundamental principles of a subject will probably be followed by decent marks.

This whole matters of grades boils down to the question of why we really came to college in the first place. It is true that we want a good record here at the University. But more than that, we believe that our four years at college will prepare us to do a better job in our life's work and will help us to be a better all-around individual. This development of knowledge, confidence, and personality is the real purpose of college. Until we recognize this purpose, we cannot do an effective job in our life at this University.—R.S.



"Hand me my crutches, Mary!

"Doc or no Doc . . . no wounded leg is keeping ME *home on Election Day!* When I was over in Korea, *one* of the big things we figured we were fighting for was the right to vote as we please.

"Just look at that crowd! Seems like *everybody* in town's turning out to vote today. In fact, it's been predicted that more than 55 million people all over the nation will be voting!

"Heard a fellow the other day call it 'National *Beef* Day'. Says he, we *all* beef at one time or another about our local, state, or national governments, or certain people in them. *And today's the day we get a chance to back up those beefs with ballots!*

"Whether we squawk about corruption by public officials . . . about wasteful squandering of our hard-earned tax dollars . . . about government interfering in public utilities and private business . . . about overloading government payrolls with un-needed workers . . . or about government employees with red sympathies—Election Day is the big moment for us citizens to get it off our chests with those votes our Constitution guarantees us.

"I say, thank God we don't live in one of those commie countries where people have only hand-picked red candidates to vote for. Those poor devils just don't get a chance to vote for anybody else. Sometimes, Mary, I think we don't fully appreciate how lucky we are. *We* vote for whom we honestly think best . . . and nobody on God's green earth knows *how* we vote!

"So hand me those crutches, Honey. And get *your* hat and coat on, too. We're going to vote together . . . bum leg or no bum leg."

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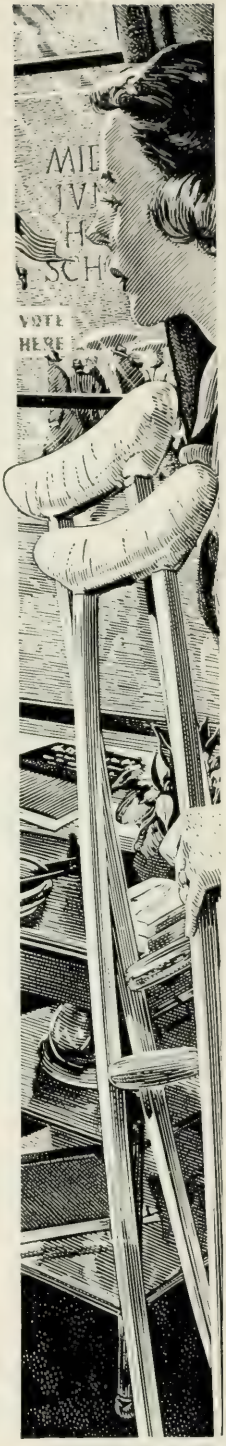

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the illinois technograph

volume 68 number 2

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our cover

This month's cover shows a North American F-86 Sabre firing part of its lethal load of rockets. This issue features the Aeronautical Engineering Department and the Aeronautical Engineer, whose untiring efforts have been responsible for the great advancements in the science of flight. (Courtesy North American Aviation Co.)

our frontispiece

Commercial aviation is dependent upon the aeronautical engineer to keep pace with the advances made in other forms of transportation. With air transportation a "must" for thousands of Americans the challenge is a dynamic influence on the engineer's ingenuity. In the picture a United Air Lines flight crew inspects an engine on one of the company's new Mainliner Convairs. The "orange peel" cowling as shown unlatches in mere seconds for swift access for mechanical maintenance. (Courtesy United Air Lines)

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improved landing gears by . . .

DROP TESTING

by Morris Isaac, A.E. '52

An airplane, in the strictest sense, is a machine whose purpose is the carrying of a load in excess of its own weight. This is true whether the airplane is a bomber, fighter, transport, or crop-duster. To carry the maximum possible load, the primary structure of the airplane must be of the lowest weight possible for the proper functioning of the machine. This low weight is achieved by designing the structure for a factor of safety of 1.0; the conditions specified by the Civil Aeronautics Board, or by the Air Force or Navy specifications, if either one is the customer for the airplane.

Before an airplane is approved, it must first be tested by the Flight and Static Test sections of the aircraft company. Flight-testing primarily furnishes data on the stability and control characteristics of the airplane. However the most gruelling treatment the airplane undergoes — more so than it would probably ever receive during its normal operating life—is reserved for the Static Test section. It is there that the airplane is pulled, bent, twisted, dropped, and generally put through the wringer, to find out just how much punishment it can take before failure.

The Drop Test

The drop test is one of the most important of these tests. Its importance lies in the fact that while landing, forces, often many times the weight of the whole airplane, are imposed at only two or three singular points. It is a well-known fact that a body can withstand an evenly distributed load better than a load concentrated at a point. When one considers the varied circumstances under which an airplane must often land—such as an emergency landing on soft ground, or a carrier landing when the sea is rough—it becomes apparent that the landing gear-connecting structure combination must be thoroughly tested to ensure safety under the most adverse landing conditions.

The purpose of the drop test, then, is to determine the strength of the landing gear as a whole, its component parts, and of the primary structure of the airplane adjacent to, and tied in with, the landing gear. This is achieved by imposing a dynamic load (the accelerated weight of the airplane itself), on the gear in accordance with specifications, and then measuring the stresses induced in the members as the load is applied. The dynamic load imposed is one which most closely simulates the load experienced by the gear in an actual landing. The fact that the tests themselves take only a few seconds, necessitates the use of special equipment and technique to get the maximum amount of information with the least possible expenditure of time.

There are generally three types of drop tests that may be performed. They are:

(1) Restrained Rotation—(Fig. 1) —The airplane is pivoted about one point. The center of gravity moves in

(*Continued on page 30*)

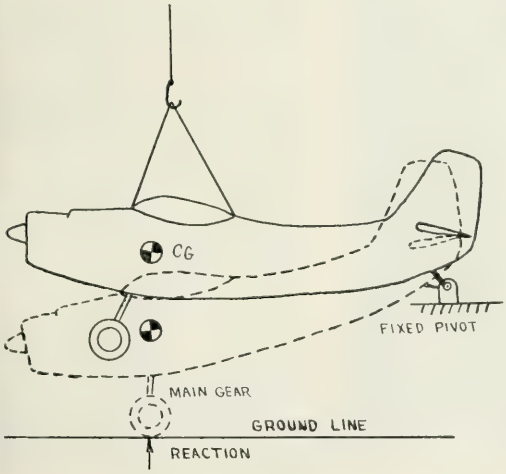


Figure 1

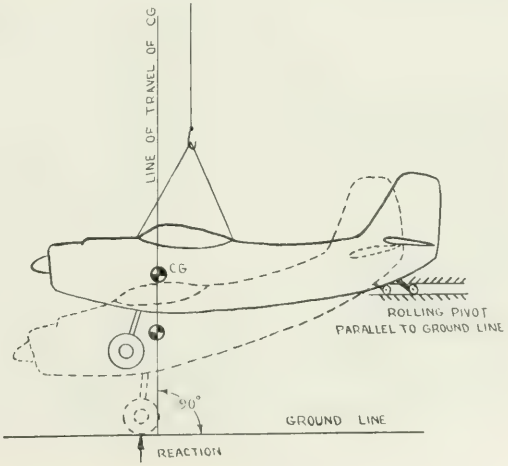


Figure 2

the Technograph features the . . .

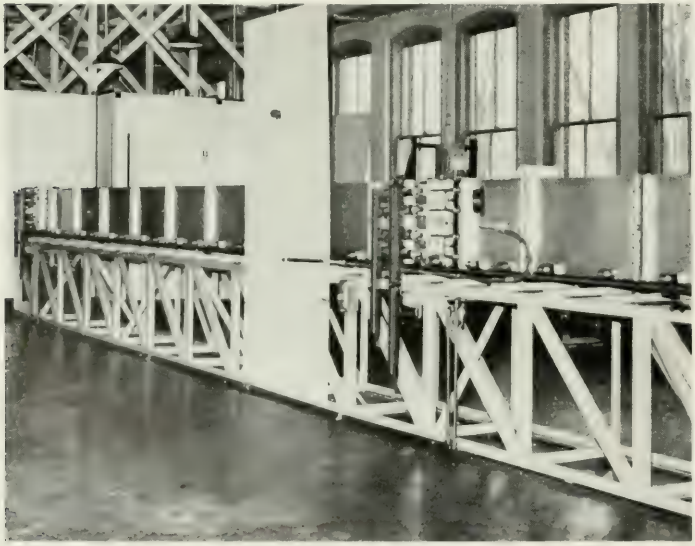
AERONAUTICAL ENGINEERING DEPARTMENT

by Wendell J. Thompson and Bernard K. Genetti

Aeronautical Engineering is a comparative youngster among the many branches of modern engineering. Its newness, rapid growth, and great present-day importance, as well as the large part it promises to play in the future, all combine to present a great challenge to the educational institutions upon which this field depends for its manpower. To teach the basic material common to all engineering, the material especially applicable to this field, and prepare the young engineer to face the new situations with which aeronautical engineering will always be confronted, is no small task.

To introduce you to the Aeronautical Engineering Department of the University of Illinois, it will be appropriate to inject here a brief history of the department. In September 1944, a separate Department of Aeronautical Engineering was established upon the recommendation of the Committee of Aeronautical Engineering. Professor H. S. Stillwell was appointed to his present position as head of the department and proceeded with the work of building from the ground up. The second member of the teaching staff, Professor R. W. McCloy, assumed his duties on July 1, 1945 and the department was under way.

The department was assigned offices in the Transportation Building. The Locomotive Laboratory was assigned for the use of the department and a survey was started to determine which other campus laboratories, classrooms, and offices would be turned over to Aeronautical Engineering. Design of a demonstration wind-tunnel for location in the old Locomotive Laboratory was started. Wide use was made during this expansion period of many pieces of equipment purchased from surplus property. Many expensive items were thus obtained which could not have been procured from normal sources under the existing budget. Quonset 1, the first of the Aeronautical Engineering Department's buildings to be located at the University Airport, was completed in the academic year 1947-48. It was to house the new Flow Laboratory of which the suporsonic wind tunnel was to be a part. In the summer of 1949, the department acquired the Machine Tool Laboratory building. This building now houses the Aircraft Structures Laboratory in addition to providing office and classroom space. It also provides spoce for the Shock Tube Laboratory.



The shock tube, a valuable tool in compressible flow research, is housed in Aeronautical Engineering Laboratory "B." (All photos courtesy Aero. Eng. Dept.)

In 1944, an eight semester curriculum leading to the degree of Bachelor of Science in Aeronautical Engineering was established. The first student to receive this degree, Wayne E. Zeiglemiller, was graduated in June 1946. Graduate work, leading to the degree of Master of Science in Aeronautical Engineering, was first offered in the fall semester of 1948. Since that time, the graduate program has been greatly expanded without lowering the original high standards. During the year 1951-52, plans were laid for the development of a graduate program leading to the Ph.D.

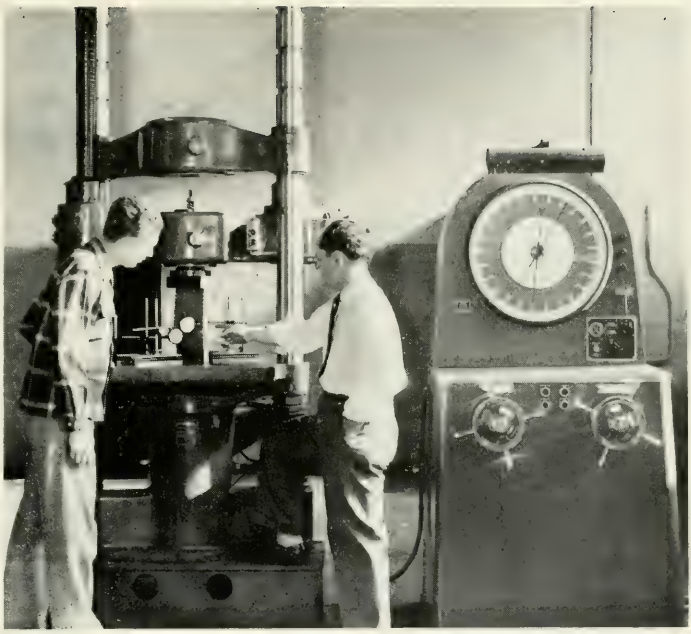
In February 1945, the department got its start as an independent research organization with work of a classified nature for the Bureau of Ordnance of the Navy.

During the second semester of the 1945-46 academic year, a Student Branch of the Institute of Aeronautical Sciences was established.

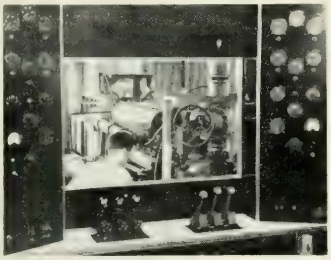
Staff and Personnel

The staff of the Department of Aeronautical Engineering is headed by Professor H. S. Stillwell, Drs. J. M. Coan and H. H. Hilton devote themselves mainly to the field of aircraft structures. Dr. H. C. Fletcher is in charge of the Shock Tube Laboratory. The field of aerodynamics is Dr. M. Z. Krzywoblocki's specialty, and the field of aircraft propulsion is represented by Dr. T. P. Torda and Professor R. W. McCloy. Professor A. I. Ormsbee has been awarded the Howard Hughes Fellowship for study at the California Institute of Technology. At present he is on leave of absence for the academic year of 1952-53. Professor Ormsbee's field is aerodynamics.

In addition to these men, about ten graduate students are employed on a part-time basis in both research and teaching. The non-academic staff includes two secretary-stenographers, five laboratory mechanics, and several undergraduate computers and draftsmen. The activities of the staff are not confined to teaching, as a large portion of their efforts is devoted to basic research. Many papers written by several members of the staff have been published widely, both here and abroad. Teamwork and co-operative effort between staff and students seems to be the watchword in the department. The members of the faculty maintain close contact with industry and other research organizations by taking suitable summer employment.



Testing a reinforced panel with the structure laboratory's testing machine.



Control panel and one of the two Allison engines used to provide an air supply for the new super-sonic wind tunnel and for jet engine testing.

Curriculum

The curriculum leading to the degree of Bachelor of Science in Aeronautical Engineering at the University of Illinois is designed in such a manner as to allow the student to concentrate on any one of the three major fields through selection of appropriate technical electives. These three fields are aerodynamics, aircraft propulsion, and aircraft structures. Although each student is required to take basic courses in each of the three fields, the curriculum is very flexible for the junior and senior years. In addition to specializing through the selection of electives, the student may register for a special problems course which will allow him to work on a problem of particular interest to him with close supervision by a staff member. Probably the brightest star in the picture of the aeronautical engineer educational program at the University of Illinois is the excellent, close student-staff relationship. The pattern here is to mold the curriculum in each individual case so as to produce the best results. A sincere effort is made to allow students to advance as fast as their abilities allow.

The curriculum itself is subject to constant review with an eye toward keeping abreast of the times and, when possible, a little ahead of the times. The Department of Aeronautical Engineering at the University of Illinois was ahead of the procession in relation to other institutions when the aircraft propulsion courses early switched emphasis away from reciprocating piston type engines to concentrate on the jet and rocket engines of the present and the future. The present and near future aircraft propulsion laboratories are far ahead of those possessed by most comparable institutions. Theory, engine testing, and experimental propulsion research are all given attention in the undergraduate curriculum. In the field of aerodynamics, supersonic speeds have been of primary consideration and already the study of hypersonic aerodynamics (speeds several times greater than the speed of sound) is receiving increasing attention. Directly in line with this far-sighted attitude is the plan to offer work in aeroelasticity, a new area relating aerodynamics and aircraft structures, which is very important to transonic and supersonic aircraft of today and tomorrow. Work is also planned in the fields of rotating wing aircraft (helicopters) and pilotless aircraft. A control systems course, an internal flow course, and several other advances are planned. It is planned that graduate work, leading to the Ph.D. with a major in aeronautical engineering, will be offered in 1953.

Facilities

The department has the major portion of its office and classroom space in the Transportation Building, which it shares with other departments. Aeronautical Engineering Laboratory A, the old Locomotive Laboratory, has been revamped completely to provide space for offices and a complete machine shop.

(*Continued on page 24*)

DIELECTRIC HEATING

by Henry Spies, Ag.E., '53

One of the latest applications of electricity to food production is in the field of dielectric heating.

Dielectric heating is the heating of a non-conductor with an electromagnetic field. In order to understand this phenomena, let us examine the molecular structure of a non-conductor. Some of the molecules have the centers of their positive and negative charges coincident. These are neutral molecules. Many of the molecules have the centers of their positive and negative charges in different locations in the molecule. These are called molecular dipoles. When a non-conductor containing these molecular dipoles is immersed in an electromagnetic field, the dipoles tend to turn until the line connecting the centers of charges is parallel to the field. This exerts a torque on the molecule, and moves it slightly, sometimes shifting the centers of charges at the same time. This motion of mass through a distance is work, and the friction between the moving molecules creates heat. Following this theory, when the field is changed, the dipoles will move again, generating more heat. The higher that the frequency of the electromagnetic field becomes, the greater the amount of heat generated within the substance.

This phenomena has been put to use in a number of fields since it was discovered. One of the most widely used applications is in the making of plywood and laminated wooden beams, where the heat generated in this manner is used to dry the glue between laminations.

This method of heating far surpasses the steam heating method used previously. Another application is in the bonding and welding of plastics, a small welding gun being developed in addition to the large pressures normally used. This process has also found its way into the canneries, being used for cooking and sterilization. In all the aforementioned uses, the main advantage of dielectric heat is the uniform heat that is obtainable throughout the entire thickness of a substance that does not conduct heat well.

In the food field, dielectric heating has been successfully able to thaw frozen foods in a fraction of the time that was previously required, thus preventing chemical action in the thawed portion while part of the package is still frozen. The example of ripe frozen peaches is typical. The outside of the package thawed and turned brown while the inside was still frozen. Another reason for the use of this process is the speed at which large containers can be thawed. In a commercial bakery, three weeks at room temperature was required to thaw a barrel of frozen fruit to use in baking. With this method of heating, the same barrel is thawed in an hour, with a tremendous saving in warehouse space.

Another application in the commercial food field is the preparation of compressed, dehydrated vegetable blocks. These blocks can be kept without refrigeration for one to two years and can be reconstituted with the addition of water. The vegetables are dried by ordinary means until about 80 per cent of the water is removed, leaving them limp. They are then compressed into blocks and dried by the dielectric process, taking advantage of the fact that the heat generated within the block is not proportional to the surface area exposed to the source of heat as is true in the usual heating process. In the dried blocks, approximately one pound of water is removed per kilowatt-hour of energy used.

One of the latest ideas in the field of dielectric heating is the drying of seed grains. This is a very specialized and important field. The main requirements of the field is that the grain be harvested early before losses occurr, necessitating harvest at a high moisture content. The grain must then be dried for safe storage without impairing the germination qualities of the grain. Due to the high price of seed grain and the consistent high quality that must be obtained, methods can be used that would not be either feasable or practical in any other circumstances.

For further insight into the problems of dielectric heating, let us consider the case of seed corn. This use is still in the extreme experimental stage, but it will serve as an excellent example as to what the researcher must contend with when working this type of project.

The corn will be picked early, coming from the field containing approximately 25 per cent moisture. For proper storage of corn without any type of destructive spoilage, the moisture content must be lowered to about 13 per cent. Since heat will affect the germ of the corn and reduce the percentage of kernels that will grow vigorously, the corn must not be raised to a temperature greater than 110° F. The conventional method of drying corn, that of blowing heated air through the corn, is highly inefficient after the moisture content has been lowered to about 17 per cent. For the purposes of this investigation, let us assume that the corn will be dried to this point by a forced air drier and will be delivered to the heating unit as shelled corn containing 17 per cent moisture and at outside air temperature of 50° F.

The simplest way of obtaining an electromagnetic field is charging two parallel plates, using the corn as the dielectric in the condenser. That is the type of equipment that will be used. Since this is to be a commercial unit, an input of 40 kilowatts will be considered. For the properties of corn, these very close approximations will be assumed:

Dielectric constant ..... 4.50—e'
Specific heat 0.43
Specific gravity 0.84

Since the power input varies as the square of the voltage, and the voltage must not exceed 25000 volts due to technical difficulties, we shall make the preparatory assumption of 20,000 volts *rms* input. To prevent arcing, the voltage gradient must be less than 2,000 v./in. from previous experiments. We shall assume that the parallel plate electrodes are 12" apart. In order to maintain an even heat between the electrodes (20 per cent variation) the electrodes must not be more than 1/16 of a wavelength apart. Max. freq. = $62.5 \div Le'$ where L is the distance between electrodes in feet; $f_{max} = 29$ megacycles. Use 20mc as it is easier to obtain a generator of this size and capacity at that frequency.

$w = (1.41AfE^2e'' \times 10^{-12}) \div d$

where,

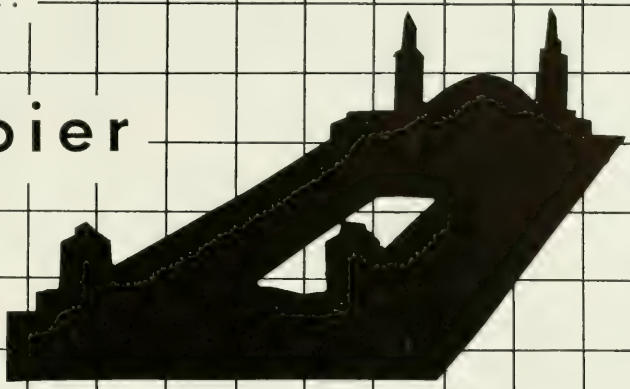
w—power input in watts
A—area of electrode sq. in.
f—frequency cps
E—voltage rms
d—thickness of corn in.
e''—e' tan — loss factor
assume 18

From this equation, the required area of electrodes is 300 sq. in., giving a batch capacity of 2 bushels. The time

(*Continued on page* 48)

— *the university of illinois at . . .*

navy pier



by Don Davoust, E.E.

PROF. R. E. KENNEDY

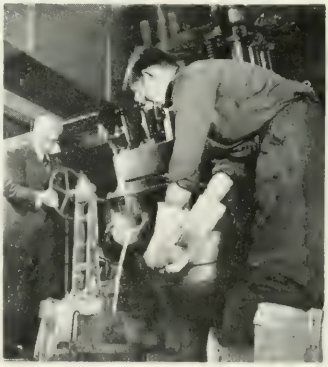
From 1887, the year he was born, to his teaching today at Navy Pier, Robert E. Kennedy has served and inspired men of engineering—both young and old. Best known as "Bob" to his many friends, Professor Kennedy began his career in 1904 with part-time foundry work while attending a foundry trade school. In the fall of 1909 he entered the University of Illinois as a freshman and was given a teaching job the next year.

While teaching at Urbana, he served as assistant secretary for the American Foundrymen's Society, worked part-time in various foundries, served two years with the Armed Services in World War I, and then received a BS degree in education. His name appeared on the University of Illinois' first "Honors Day Program," in 1925, for superior scholarship.

A summer job at the old Mitchell Motor Car Company in Racine, Wisconsin, gives him the distinction of being the first metallurgist in a foundry, thus paving the way for the benefits of metallurgy to the metal casting industry.

In 1925, Professor Kennedy left the University of Illinois to serve as technical secretary for the American Foundrymen's Society. He devoted his time to organizing chapters and meetings, and undertook the almost impossible job of organizing committees which assembled available data in papers and handbooks. He represents many advancements in the foundry industry, and is responsible for its literature. In 1934 he became secretary, a position which he held until 1945 when he became Secretary Emeritus, and was presented with the Joseph S. Seaman Gold Medal in recognition of his outstanding work for the Society.

Professor Kennedy, through his personality, enthusiasm, and knowledge has inspired many engineers now foremost in industry and education. Mr. Harry W. Dietert, who studied under Professor Kennedy at the University of Illinois, now the worlds foremost expert on sands, dedicated his book, *Foundry Core Practice*, to Robert E. Kennedy. When the Chicago Undergraduate Division was established in 1946, Professor Kennedy was called back to the education of engineers.



Professor Robert E. Kennedy (left) casting metal in the Foundry Laboratory of the Navy Pier Division of the University of Illinois.

Engineering education at the university level has great need of men of the caliber of Professor Kennedy. His devotion to his field—metal casting, his practical experience and theoretical knowledge — have combined in him qualities of leadership that gain respect for his students and his university. This respect is felt throughout the world of engineering and industry. What more could a student ask than to be an engineer who worked for such a master teacher and foundryman?

ENGINEERING SOCIETIES AT NAVY PIER

I.A.S.

The Institute of Aeronautical Sciences Student Branch has in the past month doubled its student enrollment. Through the efforts of Mr. Harold M. Skadeland, the sponsor, and the engineering student body, the I.A.S. has become one of the most promising engineering societies at the pier. Next on their agenda is a personal interview with an Army jet-pilot, speaking on jet-flight conditions. In addition to promoting social and technical contacts for its members, the Society hopes to enlarge the Aeronautical curriculum at the Pier.

A.S.C.E.

The American Society of Civil Engineers has undertaken the job of keeping the Pierites informed on the activities just north of the Pier. This is the site of Chicago's new water filtration plant.

(*Continued on page 36*)

The Technograph Tours . . .

McDonnell Aircraft

by Tom Tucker, Chem. E., '53

One of the newest American industries is the aircraft industry. Although McDonnell Aircraft Corporation is one of the youngest of the industry, it is one of the largest. In the thirteen years since its incorporation on July 6, 1939, M.A.C., as McDonnell refers to itself, has grown from two employees to about 1200 employees. In this same period, M.A.C. has increased its floor space from 1900 square feet to over 1,530,000 square feet. It has progressed from the role of a sub-contractor to the role of a leader in the industry. How this happened is a testimony to the opportunity which is open to the engineer.

With twenty-five years of aviation experience behind him, James S. McDonnell, Jr. resigned his post as chief project engineer for land planes at the Glenn L. Martin Company to go into business for himself. By October of the year of its founding, M.A.C. had expanded to 15 employees. June of 1940 brought McDonnell into its first factory . . . 37,400 square feet at Lambert-St. Louis Municipal Airport. December brought the first major airframe subcontracts. McDonnell was on the move.

September, 1941, was an important date to the young company. The U. S. Army Air Force awarded M.A.C. its first contract for an experimental plane of McDonnell design. The XP-67 was a combination fighter-bomber. It was powered by two counter-rotating engines faired into the wings on either side of the cockpit, which was no more than an enlarged portion of the wing.

The advent of the jet made the XP-67 obsolete, but M.A.C. was ready. One year after the first flight of the XP-67, the first McDonnell jet took to the air in January of 1945. This was the famous "Phantom," the first jet plane to operate from an aircraft carrier. The Navy was so well pleased with the FH-1 "Phantom" that it placed an order with M.A.C. before the first flight from the carrier U.S.S. Franklin D. Roosevelt was made.

The next McDonnell plane to be purchased in quantity by the Navy was the F2H-1 "Banshee." The "Banshee" was bigger, faster, and better armed than its predecessor, the "Phantom." Many changes have been made in the "Banshee" since its first flight in June of 1947. In fact, the F2H-3 is now in quantity production. The "Banshee" has proven the worth of carrier based jet planes in the Korean conflict. It is faster, better-armed, and harder to hit than the propellor planes.

Two other M.A.C. jets are on order by the armed forces. They Navy has ordered the F3H-1 "Demon" and the Air Force has the F-101. The former plane is again a carrier plane. Aside from the fact that "performance (of the single engine F3H-1) will exceed by far that of the FH-1 and F2H," nothing about its speed and armament is known. The F-101 "Voodoo" was designed to escort bombers, attack distant targets, and provide close support for ground troops. Both planes have sharply swept back wings.

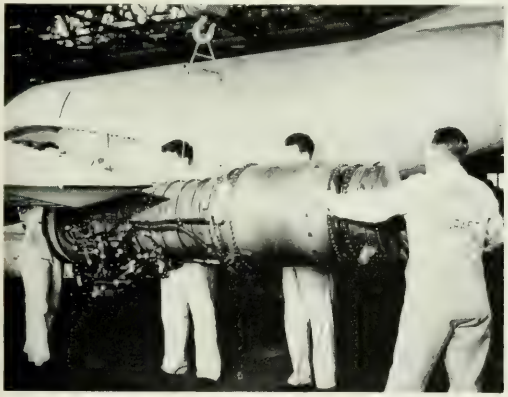
Although the most spectacular part of the M.A.C. story concerns the every-day type of plane, helicopters, guided missles, and parasites have a place in the story. In the helicopter line are the Whirlaway, an experimental twin-engine, twin-rotor machine; Little Henry, the first ram-jet helicopter (possibly the prototype of tomorrow's family helicopter); an assault transport and cargo unloader for the Navy; and an experimental "convertiplane" for the Air Force. The guided missles are both target drones and self-propelled, automatically controlled bombs. The parasite "Goblin" was designed to operate from the bomb bays of a B-36. It was launched and retrieved in mid air by the "mother" plane.

The story of an airplane generally follows this pattern. The engineering staff developes a plane which they believe to be a very good one. But, is it? Only actual flight will tell. Here the hand-made experimental models are made. First the company tests the ship, then the Navy or Air Force tests it in competition with the products of other manufacturers. Then a contract is let for the production of 100 to 200 planes which are based on the winning design, but which embodies the best principles of all the competing planes. Now the production line must be set up.

But, the modern jet airplane is not a product which can be mass-produced like an automobile. The tolerances in an airplane are much smaller than any present stamping press can turn out. Instead of forming a fuselage section in a press as the top of a car is made, the airplane part must be built up or machined from a solid piece of metal. Even so, the airplane must be manufactured in large quantities. A ten-ton airplane can not be placed on a moving belt like a two-ton car. Even so, a production line is the most efficient way to produce a large number of articles. How does the aircraft industry reconcile these facts?

The airframe starts along the sub-assembly lines as small parts such as wing ribs and spars. These pieces are assembled into wing sections, fuselage sections, and the like. Next the sections are put together to form an entire wing, tail, or fuselage. Finally the major parts of the plane reach the final assembly line. Here the plane takes shape. Large overhead cranes move the growing airframe from one station on the assembly line to the next. At one, the landing gear will be attached, at another guns are put in place, until the plane is ready to be flown.

Before any plane is turned over to the buyer, be it Air Force or Navy, McDonnell gives the plane a complete test on the ground and in the air. Then the customer repeats the flight test and the ship is on its way to defending our country.



Installing the two powerful jet engines in the Banshee, one of the final assembly procedures.

An additional difficulty in mass producing airplanes is the fact that an airplane is never a stock product. Every week, about 100 changes are made in the aircraft in production. These may be minor, such as relocating the cockpit-cover release, or they may be major, such as an improved fire-fighting system. Every change, however, must be approved by the armed service which will buy the plane.

How important is the engineer to M.A.C.? A rough idea can be obtained from the following figures: during World War II, there was one engineer to every ten production workers; today, there is one engineer to every three production workers. Of M.A.C.'s 12,000 employees, about 2,000 are engineers. Another insight to the importance of the engineer is found in the officers of the company. James S. McDonnell, Jr., the founder and president is an engineer. The vice-president and a large majority of the department heads are engineers. The entire McDonnell organization is based on the engineer.

In thirteen years, M.A.C. has grown from a new member of the aircraft industry to an important producer

With aircraft in the early stages of construction as a backdrop, a finished Banshee sits in the final assembly hangar. (All photos courtesy McDonnell Aircraft Corp.)

of aircraft. Much of the growth was due to World War II, but the chief reason for McDonnell growth is the engineer. When other aircraft manufacturers cut back after the War, M.A.C. kept on expanding. Of course a company does not expand without an idea of increased production. While other manufacturers lost their government contracts in part or whole, McDonnell received new and bigger contracts than it had held in the past. The very obvious reason for this paradox is the quality of the M.A.C. product. This quality is due to both the production worker and the engineer. Primarily, M.A.C. gives credit to the engineering staff which continually comes up with new and better planes. Thus McDonnell has more than doubled its wartime production, most of this growth coming before Korea.

As stated above, McDonnell became a leader by making top-notch goods. It is the company policy to remain a leader by the same method. M.A.C. is not a manufacturer only, it is a research company. Many of the buildings which have been built recently or are being built now are for research work. A new micro-wave laboratory for radar research, a new low-speed wind tunnel, a low pressure chamber to simulate high altitudes, and a new propulsion laboratory to study ram-jets and after-burners are among the new structures at M.A.C.

The McDonnell plant is located at the edge of Lambert-St. Louis Municipal Airport. The plant is new and modern, having been constructed during the last war. A large cafeteria, which often serves foreign dishes as well as the American stand-bys, is located under the production area. M.A.C. also encourages its employees to take advantage of the sports, hobbies, and social activities sponsored by the company.

(Continued on page 44)

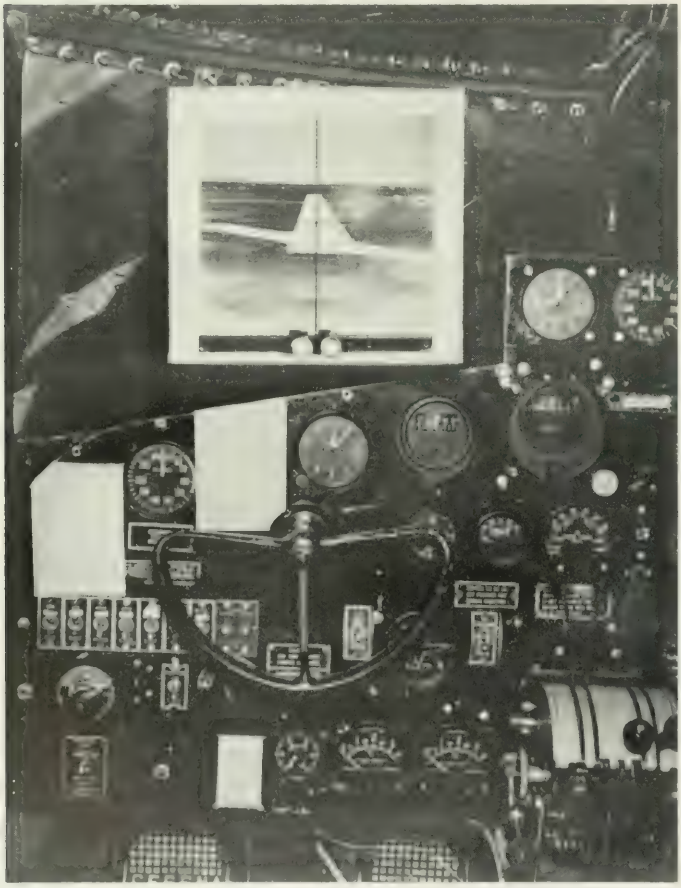
an element of aviation . . .

Human Engineering

by Howie Hadler, Ag.E., '55

Great strides have been taken in the advancement of aviation. The speed, size, payload, and powerplant efficiency of airplanes has been increased greatly by extensive research and laboratory experimentation. But quite often, in the midst of this research, the most important element of aviation—the human element—has been largely neglected.

It is this factor with which the aviation psychology laboratory of the Department of Psychology works. The laboratory, located at the University of Illinois airport, studies pilot reaction under different conditions produced by various engineering factors. The function of the laboratory is to work toward the designing of equipment which will take advantage of the aptitudes of man, as opposed to most laboratory experimentation which works toward the designing of equipment to take advantage of mechanical factors, leaving the pilot to adjust himself to these differences.



The flight periscope mounted above the control panel of the aircraft shows the runway of the University of Illinois airport as it would appear to the pilot. The study of the flight periscope is a major experiment in the aviation psychology laboratory.

The general work of the laboratory deals with the design of instrument displays and synthetic flight trainers and their characteristics. The research conducted by the laboratory is made possible by funds provided by the Special Devices Center, Office of Naval Research and Human Resources Center, USAF, under contract with the University of Illinois.

A major part of the work conducted by the laboratory is with various instrument displays and their effect on the ability of the pilot to use the information presented by the instruments easily and accurately. Special emphasis is placed on navigation instruments. The problem is to determine what information is presented, how this information is presented, and whether the information is sufficient for the pilot to accurately control and navigate the aircraft.

The first part of the project was to standardize the present instrument displays and individual instruments in a way which will be most beneficial for the pilot. The individual instruments and the complete instrument display had to be arranged in such a way that the pilot could easily read each instrument and comprehend the information presented by the instruments quickly and accurately.

The standardization involves the redesigning of the instrument panel and many of the individual instruments. The work of the laboratory is mostly concerned with artificial horizons and instrument displays for omni-directional radio range. Only part of the problem is solved by standardization however. The instrument must also be standardized to a design which incorporates the desirable characteristics of an instrument and eliminates as many of the undesirable qualities as possible. Various instruments and displays must be tested to determine which best conforms with the pilot's natural abilities.

The laboratory is quite interested in the effect of the instrument display under air traffic control conditions. Air traffic control is a major flight problem and the instrument display in the

(*Continued on page 32*)

introducing . . .

by Martin Goldstein, Chem. E., '55, Bob Schrader, Chem. E., '54, and Maurice Garnholz, Aero. E., '56

PROF. H. S. STILLWELL

Professor H. S. Stillwell, Head of the Department of Aeronautical Engineering, has been here at Illinois since the department began in 1945. Originally from Independence, Missouri, he received his B. S. and M. S. degrees from the University of Minnesota in 1939 and 1940 respectively. Since then he has had quite an extensive amount of experience. He has taught at his alma mater and has been the head of the aeronautical department at the University of Kansas. His most recent job has been engineering work with North American Aviation in California. Previously, he had held positions with Chance-Vought at Stratford, Connecticut; Porterfield Aircraft at Kansas City, Missouri; and Consolidated Aircraft at San Diego, California. At John Hopkins Physics Laboratories he was consultant on guided missiles. High speed propellors were

PROF. HENRY S. STILWELL

his concern while with Aero-Products Division of General Motors Corporation. Professor Stillwell also did consulting work for the Air Force, both here in the United States and in Europe.

As probably would be expected, Professor Stillwell's opinion of the future in aircraft is very enthusiastic. He believes that a young man who has an interest in his work and who will apply himself has before him an excellent future in the aircraft industry. He only wishes that more research could be done in the field of commercial and private flying. More people with original ideas are needed both in the aircraft industry and elsewhere. Professor Stillwell believes that we are on the brink of a newer and bigger era in aviation.

Following his own words, "Everyone should find work that is interesting to him," Professor Stillwell finds himself very happily absorbed with his profession. To him his work is his hobby. He enjoys working with students and especially likes to see the results he obtains from teaching. He also has a strong desire to meet more of the freshmen enrolled in aeronautical engineering. In his mind, as in many others, a close student-staff relationship is necessary for a successful educational arrangement.

A common mistake made about aeronautical engineering is that it is a specialized field. This is not true. Although there are three general classes —aerodynamics, structure, and propulsion—numerous branches and combinations spring forth from them.

Like the mailman who goes hiking on his day off, Professor Stillwell spends as much spare time as possible at his favorite hobby—flying. The rest of his leisure time is taken up by occasional swims and his three young children.

Very efficiently, Professor Stillwell manages to guide his well-run department. We of the U. of I., and especially those of us under him, can be justified in being proud of the competent head the aeronautical department has in Professor H. S. Stillwell.

HANK KALAPACA

The *Technograph* is especially fortunate this term in having Hank Kalapaca, last year's editor, around as a special advisor. Hank will receive his degree in engineering physics this February. Until then, he is continuing to work hard for the *Tech*. His final appearance in print for the *Tech* will come in the December issue as an article on digital computers.

Hank is from the west side of Chicago, where he attended Tuley high school. Hank was also a B.M.O.C. at Tuley. He was vice-president of his senior class and was active in the physics and civics societies. Since he had always been interested in atomic physics, Hank enrolled in the engineering physics curriculum here.

Hank's first public appearance on campus came during the 1950 Engineering Open House, when he represented a space man bound for Venus in the Open House parade. Since then Hank has hardly ever left the public eye. He was chairman of the YMCA international supper club as a sophomore. He has also received many honors, belong-

HANK KALAPACA

ing to Phi Eta Sigma and Sigma Tau and being chosen last year as a Knight of St. Pat. Also he was honored as one of the top 100 activity leaders on campus last year.

Hank first became interested in the *Technograph* when he received a letter about joining the staff which was sent to freshman engineers who had good rhetoric grades. His first article, on space travel, appeared in the December, 1951 issue. In May of 1951 Hank was chosen editor of the *Technograph* for 1951-52 school year. Hank has done an excellent job of running the *Tech*. Also, his editorial on college athletics was highly praised by critics.

Most of Hank's spare time is taken up by a certain Miss Mary Donley. Mary and Hank will be married this coming February. Next to Mary, Hank's most absorbing outside interest is hypnotism. He first became interested in the subject when he was around fourteen or fifteen. By now he is a proficient hypnotist.

Hank's immediate future after graduation will be taken up by the

(Continued on page 26)

they take it for granted . . .

ENGLISH AND ENGINEERING

by George F. Scheer

EDITOR'S NOTE: Here is a timely but of material for consideration that hits a particular weakness in many of our educations. At the beginning of this new school year we may well benefit by "turning the grammatical leaf" and concentrating our efforts in our own behalf with a resolution toward literacy.

The student who will not take English composition and literature seriously because he believes that the scientific or professional field to which he aspires doesn't require it, is in for a surprise. This was brought out in a recent survey among hundreds of American businessmen, industrialists, and government officials, which proves without question that it is not enough for technicians to be masters of their trade. Today opportunities for jobs and for expanding futures are closely related not only to man's mastery of his specialized skills but also to the effectiveness with which he can handle that basic humanity, English.

Businessmen admit candidly that the best jobs go to men who have acquired, in addition to technical abilities, the broader cultural background and the felicity of speech and expression which comes with an understanding and appreciation of English most of all.

Kendall A. Redfield, president of Asgrow Export Corporation, is typical of those who do not believe that technical training is enough. He insists that an electrical engineer "simply must have the ability to express himself clearly, both to ask questions, indicate that he understands the subject, and in giving instructions to others."

General Motors Corporation is particularly interested in "individuals who can express themselves well, both orally and in written reports." Socony-Vacuum, one of the world's leading oil companies, "takes for granted a good knowledge of English."

Many businessmen sell at the same price the same commodity offered by their competitors. In reality these firms sell service, and the only edge one has over another is the finesse with which this tangible is sold. Such a business is the fabulous Manhattan Storage and Warehouse Company, the biggest depository of household goods ever to operate under one roof, the firm which cares for Kreisler's violins, and during World War II stored for the British government (for an astronomical fee) all the peacetime fittings, from bathtubs to chandeliers, of the luxury liners Queen Mary and Queen Elizabeth. Its vice president thinks that "it is obvious that a command of the English language is important in a business where there is daily contact with the public, and this is very important when there is nothing to sell except service."

The number of people that fail to survive the ordeal of an employment interview because of their lack of common English is amazing. Time after time it is possible to see young people with responsible positions fail to secure their immediate and long range goals because of (a) their failure to make themselves understood, and (b) the poor impression they make in speaking.

Repeatedly executives suggest that promotions usually depend as much upon the ability to express oneself as upon technical abilities. W. L. Johnson, of Bell and Howell Company, manufacturers of cameras and other optical instruments, confesses that "on some occasions in the past several years, instances have come to our attention, where possible promotions have been reconsidered because of the individual's inability effectively to speak and write English . . . Certainly we feel that effective speech and writing is a necessary requisite for our executive level personnel."

Businessmen warn that ordinary, careless knowledge is insufficient. To use some of their phrases, they seek young people with the ability "to use good English, orally and in writing," . . . "to be not only articulate, but forcefully so," . . . . "to use correct spelling and grammer," . . . . "to acquire and use effectively a large vocabulary," . . . "to know the root sources and origins of words."

And they are not satisfied that English generally is being well enough taught. Although Philip D. Reed, of General Electric, only hinted that he thought the subject was not always properly taught, other executives were explicit in condemning the quality of much of the teaching in this field. The Foreign Sales Manager of the Baldwin Piano Company says that in his estimation American schools and colleges "do not give the subject of English sufficient importance, judging from the lack of good spelling, puntuation, and proper grammar used even by college graduates." Clarence I. Bau, acting director, Areas Division, Department of Commerce, Office of International Trade, says that his office finds that "very few college students" can use "the English language orally and in writing both concisely and precisely." The Sales Manager of the Interchemical Corporation thinks that English is "woefully neglected in our schools and colleges."

John N. McDonnell, vice president of the Shering Corporation, lays the blame for the prevalence of poor English directly upon the secondary school wherein the firm foundations for good English should be laid. Says McDonnell, "Too few specialists in the technical and scientific fields, such as the chemists, pharmacists, engineers, and others, are skilled in simple composition; grammar, and spelling. This is not a criticism of college training, of course, but instead rates as an indictment of secondary school education."

It is obvious that in order to glean full benefit from the educational opportunities now presented, as well as facilitating advancement—after graduation a comprehensive knowledge of proper expression is imperative. The engineering student of today, particularly inadquate in this respect, may well pause a moment and consider the importance of good English!

Father: "Why were you downstairs with that fellow so long last night?"

Sweet young thing: "Well, the least I can do when a fellow takes me to the movies is to kiss him goodnight."

Father: "That's true."

Sweet young thing: "Well, he took me to Ciro's."

* * *

Hubby: "Of all the crazy things. That fellow up on the third floor says that he has kissed every married woman but one in this apartment house."

Wife: "I'll bet it's that stuck up Mrs. Bailey on the third floor."

* * *

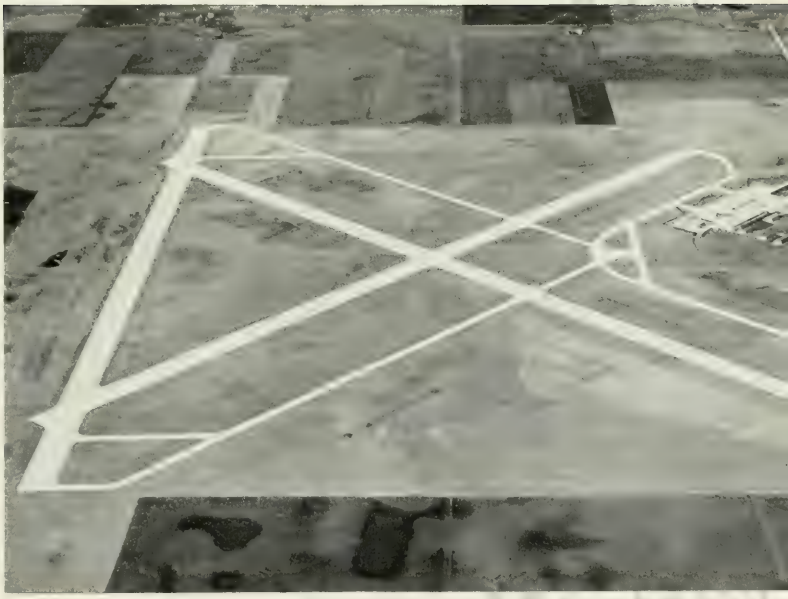
"Do you have many lines to speak in the new play?"

"No, I take the part of the husband."

radar in . . .

Weather Forecasting

by Bob Schrader, Chem. E., '54



Many times in the past half-century science and engineering have arisen to solve a need or meet a problem almost before the need or problem was known to exist. A good example of this recently field of hydro-meteorology.

All through the midwest and especially in Illinois a growing shortage of water became apparent. Underground water tables have already dropped seriously in a few industrial areas. This water shortage called for new and better knowledge of our water supply. The standard rain gauge used today can never give the data on rainfall that is desired by engineers and meteorologists. Even over a small area a very large number of rain gauges would be required. This is because the intensity of rainfall varies greatly. An inch of rain may fall on one particular spot, while a mile or two away no rain at all may fall. And now, just as the need for knowledge of our water supply increases, a new method for tracking rainstorms and measuring rainfall has emerged on the horizon. Radar has entered the field of hydro-mteeorology.

The use of radar in studying weather got its start in 1947 when there was great interest in possible rainmaking by seeding clouds with dry ice or iodide Company of El Paso, Illinois, in cooperation with State Water Survey located here at Champaign, began to study rainmaking in earnest. Pfeister became so interested that it purchased a war surplus radar set for tracking both aircraft and rainfall during any rainmaking attempts.

Even though rainmaking did not seem necessary in Illinois, the value of radar in tracking rain storms became evident. It was even thought that radar might possibly be able to determine the quantity of rainfall. A raingauge network was installed in the spring of 1948 in order to check radar results. Radar studies using this raingauge network were continued in 1949 and 1950. These studies proved to be of little value because of the "ground clutter" appearing on the radar scope, caused by trees and structures close to the radar.

Much was learned at El Paso about the nature of thunderstorm rainfall. It was already known that thunderstorms consisted of three or more adjacent cells of heavy rainfall. Studies at El Paso showed that these cells may vary from one to thirty miles in diameter and that the duration of moderate or heavy rainfall from a cell could vary from a few minutes to one hour.

During the last year the water survey researchers moved to Champaign, locating in a new building at the University of Illinois airport. They are now con-

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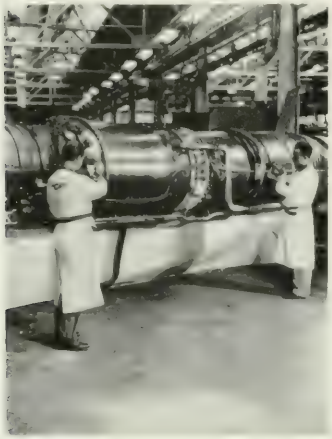
skimming industrial headlines

Edited by Charles LaRobardier, M.E., '55

World's Most Powerful Jet Engine

The Navy and the Westinghouse Electric Corporation have announced that Westinghouse has developed and placed in production the world's most powerful qualified turbojet aircraft engine. It develops thrust equivalent to approximately 25,000 horsepower at today's jet flight speeds.

"The new power plant will be the first jet engine in the world to provide



Technicians at work on Westinghouse's 25,000 horsepower turbo-jet engine. (All cuts courtesy of Westinghouse.)

constant speed drive for airplane accessories as an integral part of the engine," said Frank L. Snyder, manager of the Westinghouse Aviation Gas Turbine Division, Philadelphia, Pa. "This revolutionary feature will permit designers to make substantial savings in weight and space in new planes, both vital factors in maintaining aircraft superiority."

The new aircraft power plant has just successfully completed the Defense Department's grueling 150-hour qualification test, which all new engines must pass to be eligible for quantity production. The test was equivalent to more than 75,000 miles of actual flight, or three times around the world at the equator.

Several new fighter planes, all of which are scheduled for early production for the U.S. Navy, are expected to be powered by the new engine. These will include the McDonnell F3H "Demon" and the Douglas F4D "Skyray."

The new engine is an outgrowth of the original Westinghouse J40 engine which, when announced last year, was the most powerful turbojet in the world to qualify for production. The new engine thus assumes the role of leadership previously held by the earlier model.

Afterburner Reheats Gases, Boosts Power

The tremendous power of the new J40 is partly developed through the use of an afterburner which reheats the exhaust gases after they leave the turbine but before they emerge as a jet stream, Mr. Snyder revealed.

The new engine is of the axial flow or straight-through design. Almost 25 feet long and about 40 inches in diameter, it is exceptionally light and produces more thrust per square inch of frontal area than any other turbojet.

"This single engine is two and one-half times as powerful as the combined four engines on a B-29 Superfortress," Mr. Snyder declared, "but its weight, approximately 3,500 pounds, is less than that of only one of the famous bomber's engines and propellers. And still more powerful versions of the J40 are under development."

Saves Critical Materials

"Substantial amounts of two of our most critical metals — columbium and cobalt — have been eliminated in the new J40. Even greater savings of these and other scarce materials will be effected in newer versions of the engine," Mr. Snyder said.

A new low-cost fuel especially developed for use in high-flying jets and designated as "JP-4", was used throughout the qualification test here, engineers reported. The new J40 thus becomes the first Navy-sponsored turbojet to qualify on the new fuel.

Mounts for World's Most Powerful Telescopes

Mechanical mounts for the two largest, and most powerful and accurate instruments ever built to study the sun's corona are now undergoing tests at the Sunnyvale, Calif., plant of Westinghouse Electric Corporation. The instruments are called coronagraphs.

After completion of "dry runs" on these instruments, using electronic devices to double for the missing giant lens and sun, special optical systems and instruments will be installed. The two coronagraphs will then probe the sun's secrets from high-altitude, dust-free and haze-free observatories atop Fremont Pass in the Colorado Rockies, and on Sacramento Peak, near High Rolls, N.M.

Scientists, through use of the two giant telescopes, hope to gain additional information about the sun's corona that will: (1) make possible highly-accurate long-range terrestrial weather forecasting; (2) enable further progress in forecasting sun-caused disturbances that often blackout or cripple the world's radio communications and intertere with

World's most powerful telescope mounted for testing.

radar operation; (3) unlock additional secrets of the atom; and (4) yield further keys to supersonic flight in the stratasphere and even higher—into the ionosphere and above.

The instruments were designed by astronomers of Harvard College Observatory and the High Altitude Observatory of Harvard College and the University of Colorado.

By creating a perpetual total eclipse

(Continued on page 22)

Dakar, capital of French West Africa, is one of the latest cities to be connected to the United States through Bell System Overseas Telephone Service. Initial period rate is only $15. You can talk to some 90 countries and territories from your telephone.

Dakar is on the line

No more than 25 years ago, American voices were landlocked. They could travel around the North American continent, but, except for Cuba, they were stopped at the coastlines.

Then in 1927 telephone people inaugurated two-way commercial radiotelephone service between New York and London. In that instant the world grew smaller.

It has kept on shrinking over the years till now such overseas calls are commonplace. In 1951, nearly 900,000 were made over Bell System facilities. Today you can speak to some 90 countries and territories, 96% of the world's telephones. Dakar, French West Africa, is one of the latest additions to the list.

On this 25th Anniversary of Bell System Overseas Telephone Service, we are busy working to make the record of the next 25 years even better. This never-ending effort to find better ways calls for the best engineering and scientific minds available. Such continued research provides constant opportunities for enterprising, talented college graduates.

BELL TELEPHONE SYSTEM

SKIMMING . . .

Continued from page 20

of the sun's bright face, the coronagraph makes possible continuous daytime photographic, spectrographic, and visual study of the sun's corona. Prior to development of the coronagraph in 1930, such studies were not possible except at times of infrequent and brief total eclipses in widely scattered locations on the earth, many of them inaccessible.

An "occulting disc" located in the coronagraph's optical system blacks out or "occults" the bright face of the sun, creating an artificial total eclipse, thus permitting study of the corona surrounding the sun.

26 Foot Box-Like Spar Serves as Optical Table

Instead of the tapering metal tube of the familiar refracting telescope, the coronagraph has a long, box-like rectangular spar of fabricated steel plate. This spar serves as a four-surfaced table 26 feet long and 40 inches by 32 inches in cross section. On its outer surfaces, the Observatory scientists can mount as many as 11 complete optical systems and other devices for solar research.

Each coronagraph has an electronic guider device actuating sensitive controls and electric motors that will keep the spar automatically and accurately aimed at the sun as the earth turns on its axis and moves through space.

At its exact center, the spar is supported on a heavy cast-iron base. A "polar axis" shaft, aligned on the North Star, permits the spar to be rotated from east to west to counteract the earth's rotation.

Bearing hubs on the stub of the polar axis shaft permit movement of the spar north and south through an arc of plus or minus 25 degrees from the plane of the earth's equator. Movement on this axis compensates for the seasonal variation of the sun' path.

To ensure always-accurate alignment of the various optical systems on the sun, surfaces of the spar must not bend more than one thousandth of an inch regardless of the spar's position. Bending is prevented by using an inner truss spar that supports the outer spar through a system of multiple hydraulic bellows and counterweights. These compensate for the bending pull of gravity.

Despite its great weight and size, the spar will be so delicately balanced and literally floated on a thin film of oil by "oil pad bearings," that an electric motor rated at only one four-thousandths horsepower will drive the 14 ton mechanism as it follows the sun.

Drilling of Curved Holes

A new method has been developed for drilling holes along an arc. Using this method—an electric arc method—holes of a diameter larger than 0.040-inch have been drilled in cast iron along an arc of a radius from about 1 to 4 inches. The electric arc method was developed in order to place thermocouple junctions inside a casting at a point not accessible by a single straight hole.

The curved hole drilling device uses the electrical circuit and cooling fluid

View of curved holes drilled by an electric arc method.

of a disintegrating machine, in this instance the Thomas Metal Master manufactured by the Clinton Machine Company. These machines remove metal in the hole to be drilled by electric arcing and subsequent quenching of the molten metal by a cooling fluid passed through the center of the hole drilling electrode. The electrode is generally a circular tube, however, any shape hole can be drilled by using triangular, square or other shaped electrodes. The arc at the electrode tip is produced by vibrating the electrode.

In the Thomas Metal Master, the current that flows when the electrode makes contact with the work piece is also the current used to break the contact between the electrode and work piece. This is done by conducting the electrode current through a coil so located that it lifts the shaft the electrode is mounted on each time the circuit is closed. When the circuit is opened, the magnetic pull ceases and electrical contact is made again as the spring loaded shaft returns the electrode to the drilling position.

In the curved hole drilling rig it is necessary to vibrate the electrode along the path of its arc and, therefore, the straight line vibration motion of conventional disintegrating machines is unsatisfactory. The curved hole apparatus uses a separate vibrator and depends on the disintegrating machine only for its coolant flow and electric current for arcing.

When drilling a hole along the path of an arc it is necessary that the electrode body follow the hole made by the tip. Arcs and helices are typical of the curves that can be drilled. Electrodes of 0.050 to 0.075-inches have been used to drill holes that have radii of about 2½ inches and an arc length up to 2-inches.

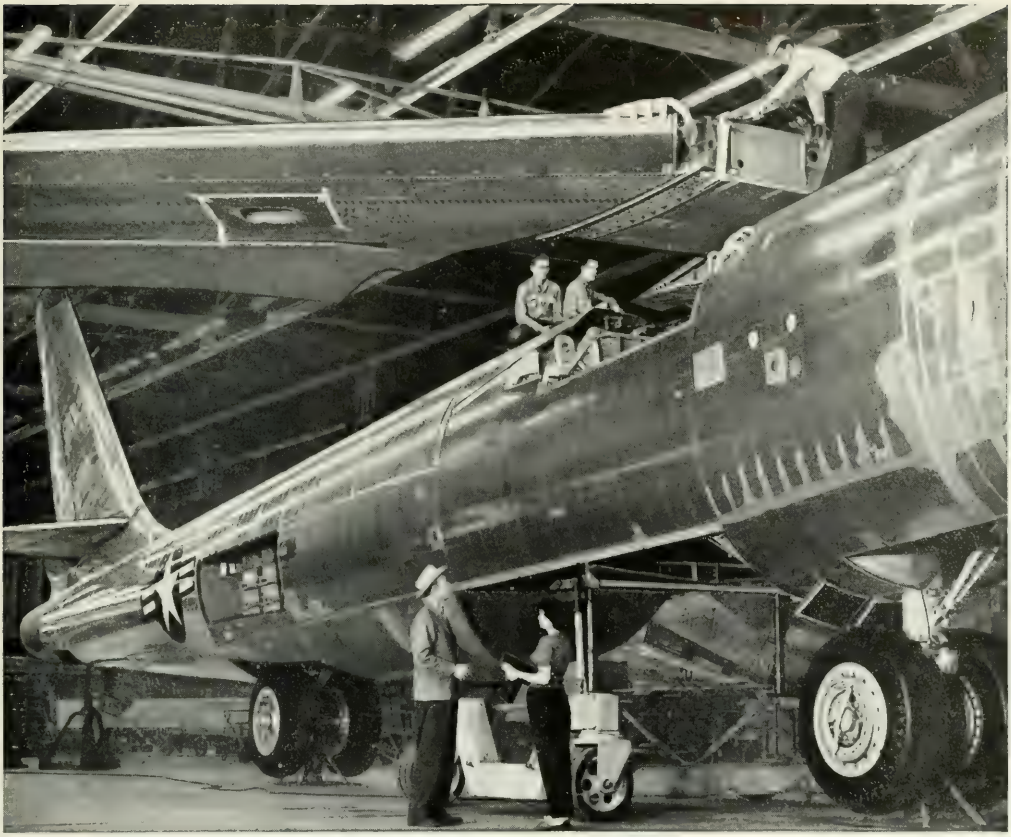
To drill a curved hole, the procedure is as follows:

An electrode is bent along the arc of the desired radius. A holder is positioned on a shaft so the electrode's center follows the proper arc. The electrode and work piece are brought into contact and the current applied. The vibrating mechanism that makes and breaks this contact consists of an electromagnet mounted on a brass tube which is equipped with a steel weight inside it that can slide freely.

As the hole is being drilled, the electromagnet is energized while the electrode is in contact with the work piece. During this interval, the steel weight is accelerated to the top of the brass tube with enough force to raise the whole assembly. This breaks electrode contact with the work piece and simultaneously cuts off the flow of current to the electromagnet. The steel weight drops to the bottom of the brass tube as the entire assembly moves downward and the electrode again makes contact with the work piece. This cycle is repeated until the hole is the required depth.

During the drilling operation, the amplitude of vibration and the force available for breaking contact can be varied by changing the voltage impressed on the coil. Inasmuch as the electrode sometimes spot-welds itself to the work piece, this simple method is used to increase the separation force and set the electrode free. The frequency of vibration is controlled by a geared variable speed motor with a cam to actuate a microswitch. The assembly was finally operated at from 4 to 6 vibrations per second.

Drilling speeds are quite slow, usually only in the order of ¾-inch per hour. The hole size varies from about 0.093-inch near the entrance to 0.078-inch near the end. This tapering is apparently unavoidable in any hole drilled by the disintegrating method.



Top production teams back up Boeing engineers

When Boeing engineers developed the revolutionary, flexible-wing B-47, their designs called for aluminum forgings larger than any ever before made, and for a completely new kind of wing "skin" ranging in thickness from 5/8" at the body joint to 3/16" at the tip.

New techniques, machines and procedures had to be worked out. Production is so precise that the eight-ton wing slips into place with less than a hairsbreadth of clearance. Many of these new procedures were "impossible" a few years ago. Today they are routine in Boeing plants. That's the kind of production teamwork Boeing engineers expect—and get.

Boeing engineers also enjoy the advantages of the finest research facilities in the industry. Their work, over the past 35 years, has given them tremendous prestige. You can share that prestige by becoming a Boeing engineer. You'll work on such long-range projects as guided missiles, nuclear-powered aircraft and the exploration of supersonic flight.

You can choose our Midwest plant at Wichita, or work in the Pacific Northwest at Seattle. Boeing provides a generous moving and travel allowance, offers you special training, a salary that grows with you—and a future of almost limitless range.

Plan *now* to build your career as a member of Boeing's distinguished Engineering personnel after graduation. Boeing has present and future openings for experienced and junior engineers in all fields, for aircraft

- **DESIGN**
- **RESEARCH**
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also for servo-mechanism and electronics designers and analysts, and for physicists and mathematicians with advanced degrees.

For further information, consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer—Personnel
Boeing Airplane Company, Seattle 14, Washington

BOEING

AERO. DEPT. . . .

(*Continued from page 11*)

The ground floor and basement, together, house the low-speed demonstration wind tunnel. This tunnel is of the closed jet, single return type. It is powered by a 50 h.p. motor generator unit driving a pusher fan. This tunnel can attain velocities of up to 130 m.p.h. in the test section. The tunnel is equipped with several types of model balances. Sufficient test models and indicating instruments are available to demonstrate all types of wind tunnel work.

Aeronautical Engineering Laboratory will be capable of both transonic and supersonic speeds. Two 1350 h.p. Allison aircraft engines, driving centrifugal compressors, provide air for both the high-speed tunnel and operation of jet engines of different types. Plans have been made to add six large diesel engines driving compressors in order to augment the present air supply. Numerous types of jet engines including the pulse jet, ram jet, and a modification of the ram jet are available for test. Complete jet engines and also their components can be tested in the high-speed tunnel at speeds up to the speed of sound (Mach Number 1).

A modified ram-jet prepared for a test at the Flow Laboratory.

Research

Since the organization of the department in 1944, research has played an important part in the activities of both the students and the staff. Most of the staff members divide their time between teaching and research. Opportunities for research are presented to the undergraduate in the form of a special problem's course in addition to a chance for employment as a computer or draftsman on a major research project. Graduate students with satisfactory qualifications may receive appointments as research assistants or research associates and all graduate students are required to conduct some independent research and submit a thesis.

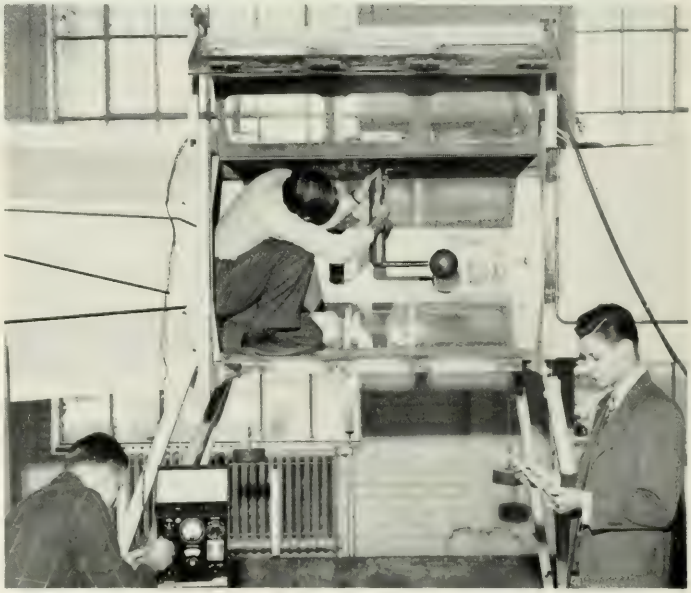
In June of 1947, under the direction of Professor H. S. Stillwell, the department embarked on a research project known as the Supersonic Propeller Problem. The object of the investigation was the development of a mathematical method for the design and analysis of propellers operating above the speed of sound. This project was completed in March of 1949 through the efforts of four staff members.

In 1950, Dr. T. P. Torda accepted a contract from Aerojet Engineering Corporation entitled "Boundary Layer Control by Continuous Surface Suction or Injection." The object of the analysis was to investigate the possibility of stall-prevention and achievement of high lift of airfoils.

(*Continued on page 26*)

B. provides additional classroom and office space, and houses both the Aircraft Structures Laboratory and the Shock Tube Laboratory. The Structures Laboratory includes a modern 120,000 pound capacity, hydraulic Baldwin-Southwark testing machine, photoelastic apparatus and also aircraft component test equipment such as a typical spar section, torque box, landing gear, and static loading for an aircraft tail section. The Shock Tube Laboratory contains the newly completed shock tube, one of the few in the nation. This highly interesting piece of laboratory equipment is designed for the study of shock phenomena encountered in supersonic flows. Interaction of shock waves and their effect on test models are only two of the interesting phenomena which this research instrument is capable of investigating. Of interest to all is the fact that shock wave interaction downstream of certain test models has produced local temperatures of the same order of magnitude as those at the surface of the sun.

The Flow Laboratory, located at the University of Illinois Airport, houses the Aircraft Propulsion Laboratory and present and projected high-speed wind tunnels. In this laboratory, a high-speed wind tunnel is under construction which



The demonstration wind tunnel which is at use in a drag-sphere experiment.

The wings of a hummingbird beat 80 times a second. Transistors, developed experimentally by RCA, oscillate electrically *300 million times a second.*

300 million times a second!

Now science has discovered a new tool—a major advance in electronic research—*the transistor.* Tiny as a kernel of corn, a speck of germanium crystal embedded with wires in plastic performs many of the functions of the electron tube.

Because it has no heated filament, no vacuum, requires no warm-up and little power, the transistor is a device which has long been needed. It is also rugged, shock-resistant, unaffected by dampness and—properly made—it will serve for many years.

Despite these advantages, the transistor, until recently, was limited to a frequency region below 50 million oscillations a second. Experimentally RCA has now increased this to *300 million times a second* and even higher goals are sought—to increase the transistor's uses.

Higher frequencies for transistors point to their use in television, radio, communications and more efficient electronic controls for airplanes and guided missiles. The small size, long life, and low power requirements of transistors suggest entirely new electronic devices—as well as use of transistors as working partners with electron tubes.

* * *

Expanding the research in electronics of solids, and the possibilities of transistors, is another example of RCA pioneering at work for your benefit. This leadership means finer performance from any product or service of RCA and RCA Victor.

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- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
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- Design of component parts such as coils, loudspeakers, capacitors.
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Also many opportunities for Mechanical and Chemical Engineers and Physicists.

AERO. DEPT. . . .

(Continued from page 24)

At the present time the department is conducting research under four separate contracts. Dr. H. H. Hilton, as project director, is conducting research under a contract with the Flight Research Laboratory of the United States Air Force. This research is on "Thermal Stresses in Media Exhibiting Temperature Dependent Viscoelastic Properties. High flight speed results in aerodynamic heating (due to friction of air moving over the plane) and temperature effects are becoming increasingly important in aircraft structures. This fundamental research will determine the influence of temperature gradients on stresses and deformation such as creep, in typical basic aircraft structural components. Four staff members and research assistants are employed on this project. In addition, Dr. Hilton plans to start related theoretical and experimental research on January 1, 1953 under Air Force sponsorship. This investigation will deal with photoelastic determination of thermal stresses.

Professor R. W. McCloy has a contract with the United States Navy for development of a modified ram jet engine. The classified nature of this work prohibits further elaboration on this project.

Dr. T. P. Torda has two research contracts of fundamental nature with the United States Air Force. The first deals with phenomena associated with mixing of two streams. This research encompasses several distinct types of mixing. Five staff members and research assistants have been employed on this contract. This work has been extended until June 1953 and will include consideration of the previously indicated cases considering temperature variations and compressibility effects.

Dr. Torda's second contract is on the analytical investigation of viscous effects in turbo machinery (compressors and turbines). This theory is applicable to design of jet aircraft engines. Previous work of this nature did not take into account viscosity effects which become important when long passages or several stages are employed in the design of a jet engine. At present, four staff members and research assistants are working on this project.

Student Activities

The organizations on campus are of particular interest to the aeronautical engineering students. These are Gamma Alpha Rho (the aeronautical engineering scholastic honor society), the Student Branch of the Institute of Aeronautical Sciences, and the Glider Club, which is jointly sponsored by the Department of Aeronautical Engineering and the Institute of Aviation.

Gamma Alpha Rho, a national organization, recognizes excellence in scholarship in aeronautical engineering. Objects of this organization are to encourage scholastic achievement and in addition to improve student-faculty relations. Several projects sponsored by this organization include establishment of an improved student counseling system and establishment of a lounge for aeronautical engineering students.

The Student Branch of the Institute of Aeronautical Sciences is a member of the Engineering Council. Among other activities, this organization sponsors an annual student lecture award given for the best seminar lecture of the year. This organization placed second in the exhibit competition of the Engineering Open House in the year 1952. The institute won first prize in the float competition of the same biannual event in the year 1950.

The Glider Club is a student and faculty organization, which provides an opportunity for flying and building of gliders. Flight instruction is also given. The Club owns a Schweitzer 119 glider and a Leister-Kaufman sail-plane. It operates at the University of Illinois Airport.

INTRODUCING . . .

(Continued from page 17)

Air Force. After he gets out of the service he would like to work in the field of either nuclear physics or digital computers. In closing his interview, Hank gave a few words of advice to underclassmen. "Don't study only your own special field," he said, "but also get some knowledge of other fields such as history and sociology. It will prove invaluable to you in later life." Thanks for the advice, Hank, and here's wishing you lots of luck in your future career.

PROF. HERBERT A. LAITINEN

Herbert A. Laitinen, professor of chemistry, who has taught here since 1940, took his work at the University of Minnesota, receiving his B. Chem. in 1936 and his Ph. D. in 1940. At present he teaches courses in quantitative analysis for chemistry majors and chemical engineers, analytical chemistry, special and instrumental methods of analysis, and electrical methods of analysis.

Professor Laitinen's research deals with electrical methods of analysis upon which subject he has published approximately fifty papers. He deals particularly with dropping mercury electrodes and amperometric titrations, polarographic methods. In conjunction with I. M. Kolthoff, professor of analytical chemistry at the University of Minnesota, he has also had one book, "pH and Electrotitrations," published in 1941.

For relaxation, Professor Laitinen enjoys photography, woodworking, and classical records of which he has a collection. During the summer he likes to take camping trips with his family.

As chairman-elect of the analytical section of the American Chemical Society, a professional society, Professor Laitinen will take over chairmanship of this group next year. He is also a member of the American Electrochemical Society, also a professional society, Phi Lambda Upsilon and Sigma Psi, honorary societies, and Alpha Chi Sigma, a chemical profession fraternity.

PROF. HERBERT A. LAITINEN

Millionaire: "Doctor, I want you to know I've remembered you in my will."

Doctor: "That's nice. Y'know, I think I'll change that last prescription."

* * *

Husband: "I've been thinking it over, Darling, and I've decided to agree with you."

Wife: "It won't do you any good. I've changed my mind."

* * *

Pat: "I et 7 eggs for breakfast."

Mike: "You should have said 'ate.' "

Pat: "You mean I et 8?"

* * *

The doctor was examining a little girl. Finally he pressed on her chest.

"It's no use, Doctor," she said. "I've tried it and I don't squeak."

The Torrington Needle Bearing ...designed for easy, effective lubrication

The Torrington Needle Bearing offers many design and operational advantages. High rated radial load capacity is combined with compact size and light weight. Installation is simple and fast. And one of the major advantages inherent in the Needle Bearing design is the ease with which it can be lubricated.

The full complement of small diameter rollers continuously carries a thin film of lubricant to all contact surfaces. The turned-in lips of the outer shell act as a retainer for lubricant within the bearing and effectively seal out foreign matter. Needle Bearings in many applications run for long periods of time without further attention to original lubrication.

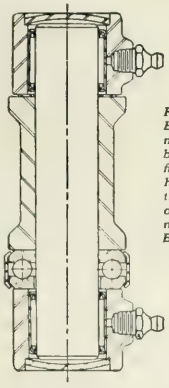

Figure 1. The Needle Bearings in this automobile king pin are lubricated with Alemite fittings through an oil hole in the center of the outer shell. These oil holes can be furnished on all Needle Bearings.

Methods of Relubrication

When Needle Bearings are shipped, they are normally protected with a high-grade slushing compound which has lubricating value at ordinary temperatures. This compound is left in the bearings in most applications.

There are several methods of providing additional lubricant to Needle Bearings:

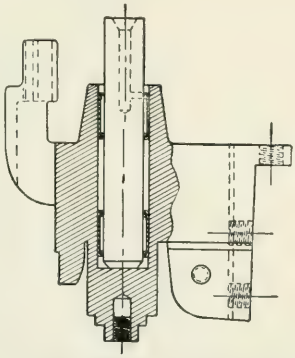

Figure 2. A hole along the axis of the shaft with a cross hole opening under the lip of the upper bearing provides lubrication to the Needle Bearings in this textile machine spindle swing bracket.

1. When lubricant is to be delivered through the housing, as in Figure 1, an oil hole is furnished in the middle of the outer shell. Care should be taken to place this hole outside the load area.

2. If it is necessary to lubricate through the shaft, a hole drilled along the shaft axis with a cross hole leading under the lip of the Needle Bearing is satisfactory. (See Figure 2.) This hole is located under the lip of the bearing rather than in the roller contact area.

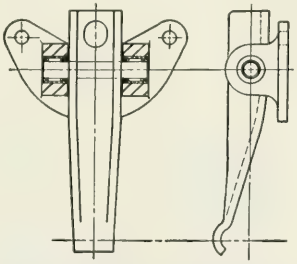

Figure 3. The Needle Bearings in the fingers of an automobile clutch are packed with grease before assembly. No additional lubrication is needed.

3. When speeds are low and loads light, Needle Bearings may be packed with grease, which often lasts for the life of the unit. Such an application is shown in Figure 3.

4. For high speeds and heavy loads, a circulating oil system is preferred, as it aids in carrying away heat as well as in providing a continuous supply of lubricant for the rollers to carry to the bearing contact surfaces. (See Figure 4.)

Selecting A Lubricant

While oil is the best lubricant, it is difficult in many cases to retain it in the bearing housing. In such cases, grease offers the best means of lubrication. In general, a soda base grease is used in the absence of moisture and a lime base grease when moisture is present. It is usually advisable to consult with a grease manufacturer before making a final decision for a particular application.

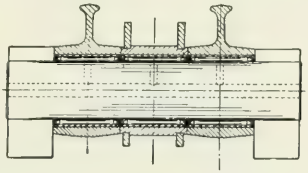

Figure 4. Heavy shock loads are easily handled by the Needle Bearings in this valve rocker arm of a large Diesel engine. Circulating oil lubrication assures a steady supply of lubricant.

If you would like more information on the use of Torrington Needle Bearings, our engineering department will be happy to help you.

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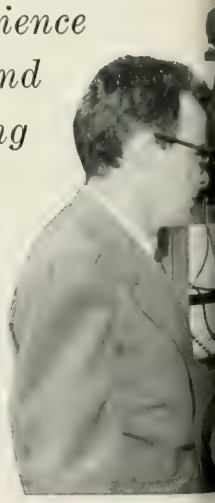
Hughes Fellowship 1952 winners Truman O. Woodruff (left) and Allen I. Ormsbee (right) are welcomed to the campus by Dr. Lee A. DuBridge, President, California Institute of Technology.

THE HOWARD HUGHES FELLOWSHIP

in science and engineering



Semiconductor research is one of the important projects of the Laboratories. A development of immediate value is the Hughes Germanium Diode employed in miniaturized airborne electronic equipment. The apparatus shown in the photograph is a vacuum furnace constructed to produce single crystals of germanium. Discussing its operation are (left to right): Hughes Fellow Allen I. Ormsbee; Dr. H. Q. North, Head of Semiconductor Department; Dr. Allen E. Puckett, Head of Missile Aerodynamics Section; and Hughes Fellow Truman O. Woodruff.

paration of men for mod-
ndustrial research ideally
ld involve both advanced
y and practical experience
n industrial laboratory
r the guidance of stimula-
associates.

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e fields of electronics en-
ring, microwave physics,
ynamics, electronic com-
puting, physical electronics, propulsion engineering, solid state physics, mechanical engineering, electron dynamics, analytical mechanics, or information theory.

Each appointment is for twelve months and provides a cash award, a salary, and tuition and research expenses. A suitable adjustment in the amount of the award is made when this will aid in the education of a promising candidate whose financial responsibilities might otherwise preclude participation in the program.

Salary provision is for the portion of time spent on advanced work in the Hughes Research and Development Laboratories. Here the holder of the Fellowship is in close personal association with many scientists and engineers who are acknowledged leaders in their fields.

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Write Howard Hughes Fellowship Committee, Hughes Research and Development Laboratories, Culver City, Los Angeles County, California, for an application form and a brochure giving all details. Completed applications must be received by the committee *not later than January 7, 1953.*

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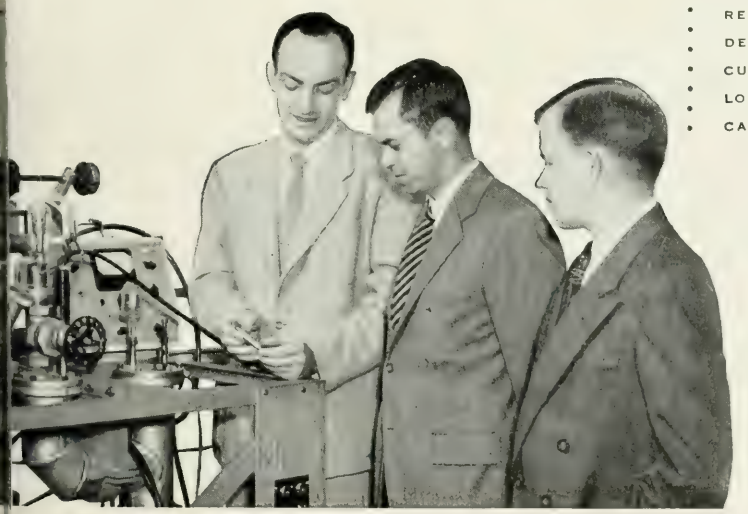

DROP TESTING . . .

(Continued from page 9)

an arc whose center is the pivot.

(2) Semi-Restrained Rotation — (Fig. 2) — The airplane is pivoted about a point which moves along a track parallel to the ground line. The center of gravity is restrained to move in a line perpendicular to the ground line.

(3) Free Translational Drop — (Fig. 3)—The airplane is unrestrained during the drop. The center of gravity moves in a line perpendicular to the ground line.

Each drop test method has its advantages. Since this article will only illustrate drop test procedure, one method, the Free Translational Drop, will be described.

Equipment

Since the drop test is to be as close an approximation of an actual landing as possible, the lift the wings experience in a real landing must be simulated during the test. This is achieved by having the lower surface of the wing strike a padded block the instant before the landing gear touches the landing platform. The energy of the wing striking the block is carried by the cable shown. The cable extends through the wing to large dash pots (which are nothing more than pistons sliding in closed cylinders) where the energy is dissipated as heat from the compression of air by the pistons.

The instant an airplane touches the ground, during an actual landing, the wheel-axle-strut combination can be considered a rigid body due to the inertia of the wheel. This means that for an instant, a high drag load (resulting in the bending of the strut) is imposed on the landing gear. The drag load decreases steadily as the wheel speeds up and is at its minimum when there is no slip between the tire and the ground. Simulation of the drag load during a drop test is achieved by one of two methods. One method is to drop the airplane onto an inclined platform so that a component of the reaction acts as a drag load.

While the airplane is in the raised position preparatory to the drop, compressed air is directed against the buckets. The wheels will turn backwards at a rate that will make the peripheral speed of the wheels equal to the hypothetical forward air speed of the airplane. When the airplane is dropped, the friction force between the tire and landing platform provides the drag load.

The Strain Gage

A most versatile and important tool used in the drop test is the resistance strain gage. This gage is merely a length of high resistance wire sandwiched between protective felt and thin paper. Its use as a strain gage is based on a principle which states that the electrical resistance of a wire increases as it is elongated. The gage is bonded to the test specimen with a strong adspecimen, both it and the gage change in length. By finding the change in the resistance of the wire gage, the unit strain of the specimen is determined. The change of resistance, and hence the strain, is found by incorporating the strain gage as one of the elements in an electrical bridge circuit.

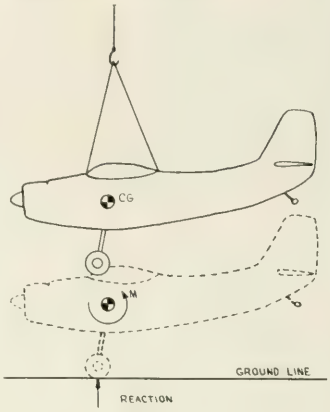

Figure 3

The use of the strain gage for measurements in dynamic loading is made possible by the fact that no time lag or inertia effect has been observed in the resistance strain gage; even for very high frequencies in reversed loading. The electric circuit used for dynamic loading is not the conventional d-c Wheatstone bridge but the a-c bridge.

In the drop test, the resistance strain gage is used not only to determine the stresses at critical points, but can also indicated the applied compressive and bending loads. Stresses at desired points can be found with the strain gage since the stress-strain relations for all metals used in aircraft industry have been determined.

Strain gages are bonded to the underside of the platform. The platform gages are then calibrated by applying varying known hydraulic loads and then noting and plotting the resulting strains. During a test, therefore, the normal load can be determined simply by finding the strain.

Preparation

Unless the airplane is properly prepared for the drop test, the results obtained may be erroneous and misleading. It is important, therefore, that as much care and technical skill be used in preparing the airplane as was originally used in designing it.

The first step is the removal from the airplane of most of the items which do not contribute to its strength. This includes engines, instruments, radio and radar equipment, armament, et cetera. The equivalent weights of these items (in the form of bags containing lead shot), are then replaced in the structure. The weights must be properly fastened so that no shifting will take place during the severest drop. Bags fastened to the surface of the wing, replace other items. There are also two large bins inside the fuselage which can be filled with shot to simulate various loading conditions. In general, it may be said that the equivalent weights must be placed so that the overall weight, center of gravity position, and moments will be the same as they were before the changes were made.

Strain gages are then bonded to the surface of the landing gear and airplane structure for the determination of bending moment and stress. At least twenty-four hours must be allowed for the complete drying of the adhesive before the gages are used. The wires that lead from the strain gages, both on the airplane and load-indicating devices, are then attached to an automatic recording a-c bridfige. This device makes it possible to record strains of up to six hundred gages almost instantaneously.

Accelerometers

Accelerometers, used for determining load factors for the drop, are then placed in different parts of the airplane. The accelerometers used can be either of two types. One type registers only the peak acceleration experienced, while the other type registers the acceleration at every instant throughout the drop. The accellerometers are usually placed at the center of gravity, wing tips, nose, and tail of the airplane. Leads from the accelerometers are attached to a recording oscillograph or some other suitable recording device.

Cable attachments are made for lifting the airplane, and except for the final preparations, the test is ready to begin. Final preparations include a continuity check of all strain gage and accelerometer circuits.

The airplane is then lifted to a predetermined drop height. Recording instruments having been switched on, the airplane is released by means of a quick-release hook and drops to the platform. Drop heights are increased as the test progress until all specifications have been met. After each drop the strain and accelerometer readings are removed

(Continued on page 48)

Clipping the wings of flying glass

No matter how you travel—by land, sea, or air—
you are protected by a sandwich of shatterproof glass

Birds flying in the airways . . . pounding waves at sea . . . emergencies on the highway or railroad—these are among the many things that can cause broken windshields and windows while you are traveling.

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DOES THE UNIVERSITY PREPARE GRADUATE ENGINEERS FOR LIFE?

LET US LOOK AT A TYPICAL EXAMPLE~~

JASPER MELLONRIND

by JOHN SPINK

I'M SO GLAD YOU FOUND A JOB, JASPER,~ BUT A CHINESE LAUNDRY IS AN UNUSUAL PLACE TO WORK

I START AT MIDNITE TONITE HEH HEH

I WISH SOMETHING HAD BEEN SAID ABOUT MONEY BUT I DIDN WISH TO SEEM FORWARD

MIDNITE

WELL~THIS IS IT~THERE'S A LIGHT UNDER THE SIDE DOOR MIGHT AS WELL GO IN

MADE IN RUSSIA

NOW IF WE CAN GET THIS IDIOT, MELLONHEAD, TO DECIPHER THESE STOLEN FORMULAE WE CAN RADIO MOSCOW~

KNOCK KNOCK

SH~THAT'S HIM

COME IN

COME IN, MELLONSKIN,--YOUR FIRST JOB WILL BE TO DECI--ER-(SLOBBER) CALCULATE THESE FORMULAE HEH HEH

NO-NO-THAT'S RIND, SIR R-I-N-D

IDIOT

LATER

MELLONSHELL'S FINISHED-RADIO MOSCOW QUICK

RIND, SIR, R-I-N-D

RUSSIAN MADE AND USED

DOT DAT DIT DAT

FBI YOU STOP THI AND HAND OVER THOSE CALCULATION

OWCH

O PSHAW

GOOD WORK, MELLONPEEL, THESE CALCULATIONS ARE COMPLETEY WORTHLESS—USELESS—— YOU'RE A HERO YOU FOOLED THEM

HERO ? USELESS ? MELLONPEEL?

BUT ~ YOU ~ GRADUATED!

I'M TRANSFERRING TO P.E. SCHOOL!

ILLINIW

DAILY WEEKLY

MELLONFOOT GETS $10,000 REWARD

The END

SPINK

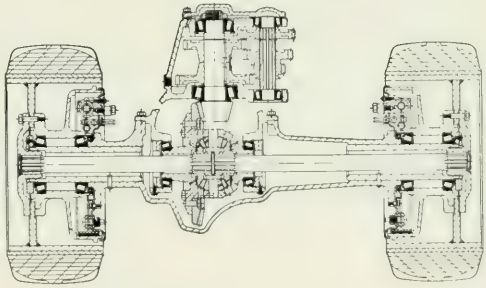
Another page for **YOUR BEARING NOTEBOOK**

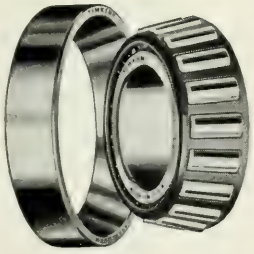
Weight-lifter is no dumbbell— it uses TIMKEN® bearings

When designing a lift truck that would handle like an automobile and lift two-ton loads, Yale and Towne engineers wanted to be sure of smooth, easy operation. That's why they mounted the wheels, pinion, differential and steering pivot on Timken® bearings. They take the high gear loads imposed by sudden starts, stops and changes in direction. Trouble-free operation is insured and maintenance time reduced. Trucks stay on the go.

How to mount a lift truck drive axle and differential on TIMKEN bearings

Two single-row Timken bearings, cone adjusted, are used in the pinion assembly. Cup-adjusted bearings are used in the differential assembly. The wheels use a standard single-row bearing mounting. The bevel pinion adjustment is obtained by the use of shims back of the cup adjacent to the pinion.





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Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help you. For a copy of the 270-page General Information Manual on Timken Bearings, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

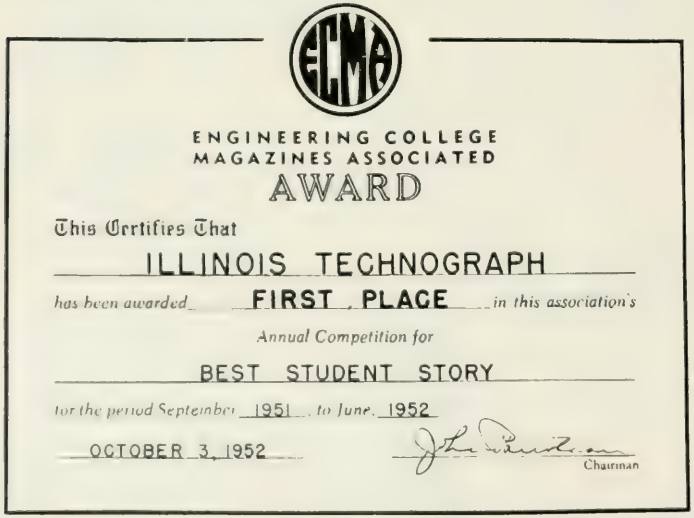
NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⧓ AND THRUST ⧓ LOADS OR ANY COMBINATION ⧓

by Peter Cattapan, Gen. E., '53 and Oliver Smith, M.E., '54

The 1952 Engineering College Magazines Associated convention held at State University of Iowa, October 2 to 4, proved to be of importance to the Illinois *Technograph* and also to the entire engineering student body on campus. Al Vejar, Bob Schrader, Pete Cattapan, Hank Kalapaca, and Professor Robert Bohl, faculty advisor, were the delegates for the *Technograph* at the convention in Iowa City, Iowa.

The big news of the convention as far as the Illini were concerned was that the 1953 ECMA convention will be held at the University of Illinois. Illinois won the nomination for the convention site against a futile, but active campaign on the part of the University of Nebraska. Warren Brandt, assistant editor of the *Technograph* added to the Illinois honors by walking off with the first place award for the best student story of the 1951-52 school year.

After an eight hour ride, the Illini representatives arrived in Iowa City on Thursday evening, October 2, and registered for the convention. On Friday morning Dean Dawson of the Iowa Engineering College formally opened the convention with a welcoming speech. Then Professor Paustian, chairman of the ECMA reported on the doings of the association since the last convention. Littell - Murray - Barnhill, Inc., the advertiser's representatives, insured their continued aid in producing better magazines.


ECMA

ENGINEERING COLLEGE
MAGAZINES ASSOCIATED
AWARD

This Certifies That

ILLINOIS TECHNOGRAPH

has been awarded FIRST PLACE in this association's

Annual Competition for

BEST STUDENT STORY

for the period September 1951 to June 1952

OCTOBER 3, 1952

Chairman

Certificate awarded to Warren H. Brandt by the Engineering College Magazines Association for his article, "U. S. Geographical Surveys," published in the February 1952 issue of the Technograph.

After lunch the convention was divided into the following committees: registration, finance, probation, convention, nomination, resolution, and ratings. Each committee discussed their problems and possible solutions. At 2:30 the delegates talked about their particular problems at one of the following four panel discussion groups: editorial, business, layout, and circulation.

Professor J. Johnson, political science instructor at Iowa, highlighted the banquet Friday evening with an address on the general political situation. After the banquet, the delegates attended an Iowa University dance, the "Harvest Hop." *The Iowa Transit*, host magazine, fixed up dates to the dance for the delegates.

A group photograph was taken at 9:30 Saturday morning. At 10:00 the reports of the committee meetings and the panel discussions were heard. The convention came to an end at noon as the delegates left with new ideas, more information, revived interest and greater goals for the future of ECMA.

About the campus . . .

Each month the *Technograph* office is deluged by thousands of letters from students all over the world containing problems to be solved by its staff. The readers seem to feel that the writers of this magazine are competent to answer all questions because the articles they write are so incomprehensible that only a genius could conceive them.

Since the May publication, however, there has been a considerable decline in questions but an increase in commendable comments. The majority of these literary "pats on the back" were initiated by the article entitled "Considerations in a Servo System" which appeared in the May issue. Everyone seems to feel that the extensive use of layman's language throughout it made

(*Continued on page 36*)

WANTED

New Ideas

To Keep America Strong in the Air

Aviation progress requires new ideas—and plenty of them. And that's why North American always has career opportunities for young engineers who do fresh thinking. North American is a company that thinks in terms of the future. That's why it has been an industry leader for 24 years, designing and developing the leading planes of World War II, the B-25 Mitchell and F-51 Mustang, and America's present day front-line fighters, the F-86 *Sabre* Jets. Today, North American is pioneering in many new fields—guided missile, jet, rocket, electronics, atomic energy—thinking ahead to keep America strong in the air.

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North American has built more airplanes than any other company in the world

BILGE . . .

(Continued from page 34)

at ridiculously easy to understand. Some have even suggested that reprints be made to be distributed to all engineering classes so that everyone may benefit by the wealth of practical information contained in it. Some of the well known political nominees in the past election were inspired by this article and had adopted for their campaign slogans the words: "A Servo System in Every House."

Of second interest in these letters is the work being done on Goodwin Street and the bridge crossing the Boneyard. One curious Ag engineer wrote, "My instructor in manure analysis has informed me that Goodwin Street is being widened to accomodate the Congress Street Superhighway that will run through Urbana. Is this true?" Another individual asked, "Is the widening of Goodwin Street due to the fact that the engineers use it to play baseball and they desire longer bases?"

Questions such as the ones mentioned above have plagued the Tech staff since they were aroused from their summer hibernation by the irritating clamor of the school bell. The drastic part of the whole matter is that up to now no one knew why Goodwin was being operated upon. Even the men who designed the undertaking were not sure of what the purpose was.

While passing by the workers one day I came upon the foreman of a construction crew and after waking him up he told me that the work was being done to make the children living in the staff residence on the corner of Green and Goodwin more happy. He went on to say that the kids are going to use Goodwin for a tricycle drag strip. Before he could say anymore he lapsed into a coma and couldn't be awakened from his snooze. I soon disproved his statement concerning the use of the street because upon measuring its length I found that it did not allow ample stopping distance for the vehicles.

So perplexing has the problem become that some of the *Tech* staff had begun to pull their hair. One unfortunate individual suffered an acute loss of cranial vegetable cuticles due to his frenzied actions when he tried to solve the problem using one hundred simultaneous equations with one hundred one unknowns. Friends have initiated a collection for a Thomas treatment.

A slip of the lip by an inebriated grad student finally broke the ice.

While at work in one of the local dispensaries removing cigarette butts from empty bottles I came upon this poor fellow slumped in a booth. With a swollen tongue he kept muttering, "They won't catch us now, they won't catch us now." Before I could get anymore from him he jumped up and headed off in the direction of Busey residence. Suddenly it hit me in the head like a wave from the Boneyard. I had the answer.

The next day I conferred with the Engineering Council and finally made them admit that they planned the whole thing. Goodwin Street was being widened for the single purpose of providing a safe exit for the engineers that would participate in the next lingerie confiscation. In addition to this a hydraulic drawbridge will replace the old bridge so that the University Police will not be able to continue their pursuit.

Choosing Goodwin Street instead of any other was really a piece of foresight because if the police resorted to discharging their firearms across the bridge at the engineers a beam of high energy neutrons could be aimed at them from the cyclotron which is located at Goodwin and the Boneyard. I am sure that this would disperse them very quickly.

Veterinarian or Engineer?

During our various musings about the campus we happened past one of those obscure little places that are placed in such a fashion that the casual passerby most always overlooks their presence. The particular place to come under the scrutiny of our over-engineered and jaundiced eye was something called the Veterinary Pathology Laboratory. It would never have given us the cause for a second thought were it not for a rather interesting incident underway in the rear of the building.

The building fronts on the imposing facade of the architectural school but it's rear is exposed to the red brick pile called the Natural Resources Building, which was our original destination anyway.

So jaunting merrily in the late afternoon sun we happened upon the unusual sight, even for Champaign-Urbana, of a veterinary operation in progress right out on the lawn behind the Laboratory.

The *piece' de resistance* was what we made out to be a former Kentucky Derby contender now gone to pasture. Still very much alive, though and well roped up to prevent any flighty escapades during the operation. Such things seem to be necessary when dealing with these animals, we were assured. Anyway, the left front leg just above the hoof was the center of attraction for a score of students appropriately garbed in the best Dr. Kildare tradition and we were somewhat out-of-place in our white bucks and slide rules. Nevertheless engineering being for man and beast alike we observed the labors of the physicians attending their mute, black-tailed charge with the care befitting Man-O-War. Just what the particular malady associated with this species Equus was we didn't have the nerve to inquire. However we were favorably impressed with the abandon with which these vets wield the scalpel, but not so much that we would transfer out of Engineering.

NAVY PIER . . .

(Continued from page 13)

From the excellent vantage point of their classrooms, all activities are closely watched and reported. On October 21, Mr. George Solter, a design engineer on the plant, spoke to a large group of students and faculty.

S.A.M.E.

The Society of American Military Engineers at Navy Pier are once again preparing a technical agenda for this semester. Movies at the 5th Army headquarters in Chicago opened their program. Captain John W. Park, just back from Korea, is sponsoring the Society this year in its activities.

A.S.M.E.

The American Society of Mechanical Engineers opened another highly successful year with Mr. Norman R. Sherman, personnel director of the Link Belt Company in Chicago, speaking on "What Industry Expects of Young Engineers". Dean Trezise, who introduced the speaker, pointed out the value of our Student organizations and their meetings to every student.

E.E.S.

The joint student branch of the American Institute of Electrical Engineers and the Institute of Radio Engineers now known as the Electrical Engineering Society at Navy Pier have started on another ambitious program. This year they are holding weekly meetings with speakers, films, and inspection trips to various industries in the Chicago area. Dean Everitt, from Urbana, visited the Society on October 14, and gave a very interesting and informative talk with slides on "Color Television."

A while back, several vats in a London brewery received a tremendous jolt from a flash of lightning. Being undamaged, the containers holding the amber fluid were allowed to complete their cycle of operation and the beer contained was considerably improved in flavor. This is the first known record of a storm actually brewing . . .

* * *

"Does your wife miss you much?"

"No. She throws remarkaby straight for a woman."

What's Happening at CRUCIBLE

about scoring and cutting rule steel

Lengths of cutting rule steel after edging

Shaped to cut wallet section (note bends, and form-holding method)

Some examples of the many shapes of bends needed

Scoring and cutting rule steel is a cold-rolled specialty steel for use in preparing dies for cutting paper, leather, rubber and other materials.

It is a pre-tempered product manufactured by skilled workmen, using precision rolling and hardening equipment, to close limits for chemistry, grain size and hardness. This product must also be capable of meeting intricate bend requirements in the hardened and tempered condition.

This specialty is furnished with round edges and in coil form to the rule manufacturer who grinds the edges — the one edge square and the other to a knife edge as well as cutting the material into desired lengths. This is sold to a die-maker who bends the rule to the required shape. This is then the nucleus of a pre-hardened die, which when properly brazed and supported is used to cut out material for display cards — aircraft parts — pocketbooks — wallets — gloves — gaskets — washers.

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But I haven't majored in aeronautical engineering

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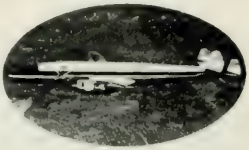
This Plane made History

The P-38 Lightning – first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History



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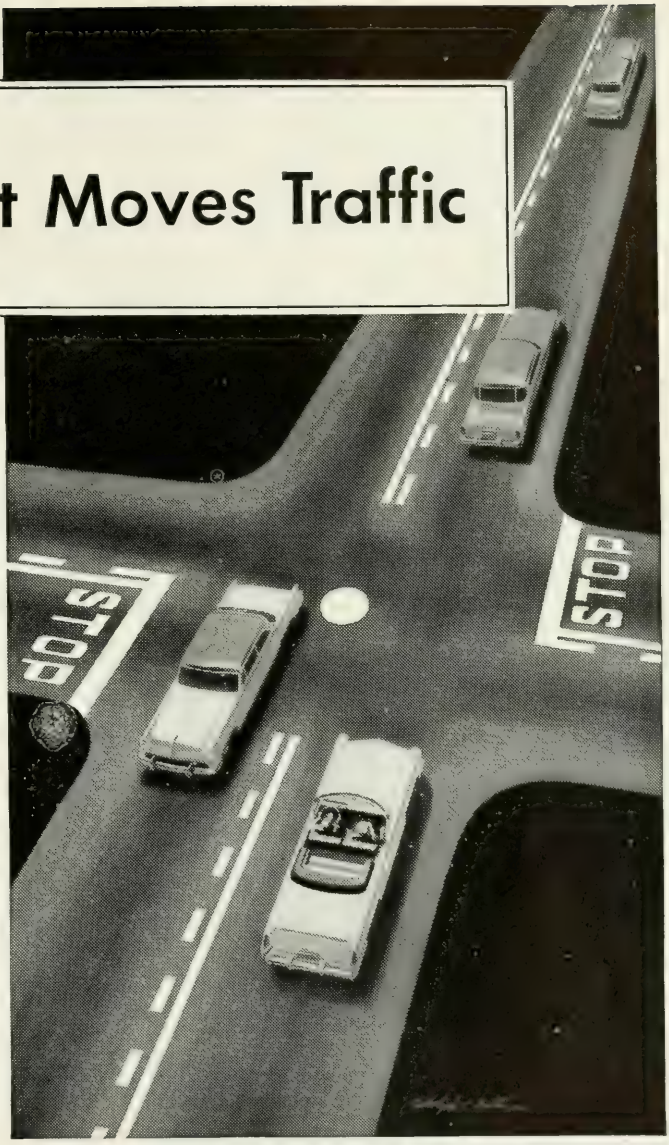
Paint That Moves Traffic



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EC52-7

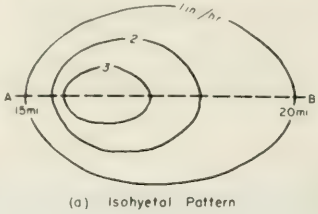
WEATHER . . .

(Continued from page 19)

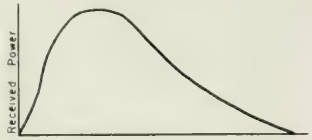
centrating their studies on a watershed in Piatt county, some twenty miles to the east.

The station at Champaign tracks rainstorms in the same manner as a normal radar station spots airplanes or other flying objects. "The radar set emits a short, intense pulse of energy which may be focused into a narrow beam and which travels at the speed of light. If the beam strikes an object, such as an airplane or a rainstorm, a small portion of the energy is reflected and returns as an "echo" to the point of transmission. It is then amplified and presented on a cathode ray tube. The range and bearing of the object are readily determined. The beam generally travels along a 'line of sight,' hence the radar cannot detect distant subjects that are near the earth's surface.

Two main methods of receiving storm data are used at the present. The "A" scope method, using a cathode-ray tube, measures the power received as the radar is directed along an area of ground. This method can best be explained by referring to figures *a* and *b* on this page. Figure *a* shows an isohyetal diagram of a storm whose nearest edge is 15 miles east of the radar. Figure *b* represents the hypothetical received power curve when the radar is directed along axis AB. The main difficulty with this method is that receiver sensitivity must be maintained at a high level so that light rain fall



(a) Isohyetal Pattern



(b) Received power curve when radar antenna is directed along AB.

may be observed. Then the amplitude of the received power curve (in figure *b*) exceeds the capacity of the receiver circuits, distorting the signal so that moderate and heavy rain intensities cannot be distinguished.

The second method uses a PPI (plan position indicator) scope. As a rotating antenna scans the area around the radar, the PPI presents an image of the storm on a circular screen. The image can then be laid out on polar coordinates. The image of the rain glows, while the rest of the screen is dark.

One of the most important uses of radar in meteorology will be to measure the amount of rainfall. Already radar can measure rainfall intensities as well as the rain gauge networks generally used. In the near future the accuracy of radar will probably be greatly improved, thus giving the weather men much valuable data on the movements of each rain cell.

The theory behind radar measurement of rainfall intensity is fairly straightforward. As can be seen from figures *a* and *b*, the power received by a radar set is dependent on the intensity of rainfall. The following equation has been developed for the power received:

$$P = \frac{KNa^6}{R^2}$$

P is the power received, N is the number of raindrops per unit volume, a is the mean radius of a raindrop, R is the distance to the storm, and K is a constant incorporating several factors which vary for each radar set.

Also a relation between raindrop size and intensity has been developed. It is as follows:

$$\text{Log } Na^6 = 1.441 \text{ Log } I - 17.302$$

with I representing rainfall intensity expressed in milimeters per hour.

Combining these two equations, we get the final relation between rainfall intensity and power received:

$$P = \frac{KI^{1.441}}{R^2}$$

The future possibilities of radar in the field of weather are virtually limitless. Approaching storms may be followed by radar and the time of their arrival predicted almost exactly. "Radar can depict precipitation patterns associated with flash floods, large floods, tornadoes, hurricanes, frontal weather, and freezing rain in winter. It will doubtless be used to study drop size and its effect on erosion. It should prove useful in irrigation works, and in controlling water supply reservoirs and hydroelectric plants." Within the next few years radar will provide the answers to many weather questions which the engineers are asking.

Prof: "This is the fifth time this week that you haven't had your homework done. What do you have to say for yourself?"

Student: "Thank God it's Friday."

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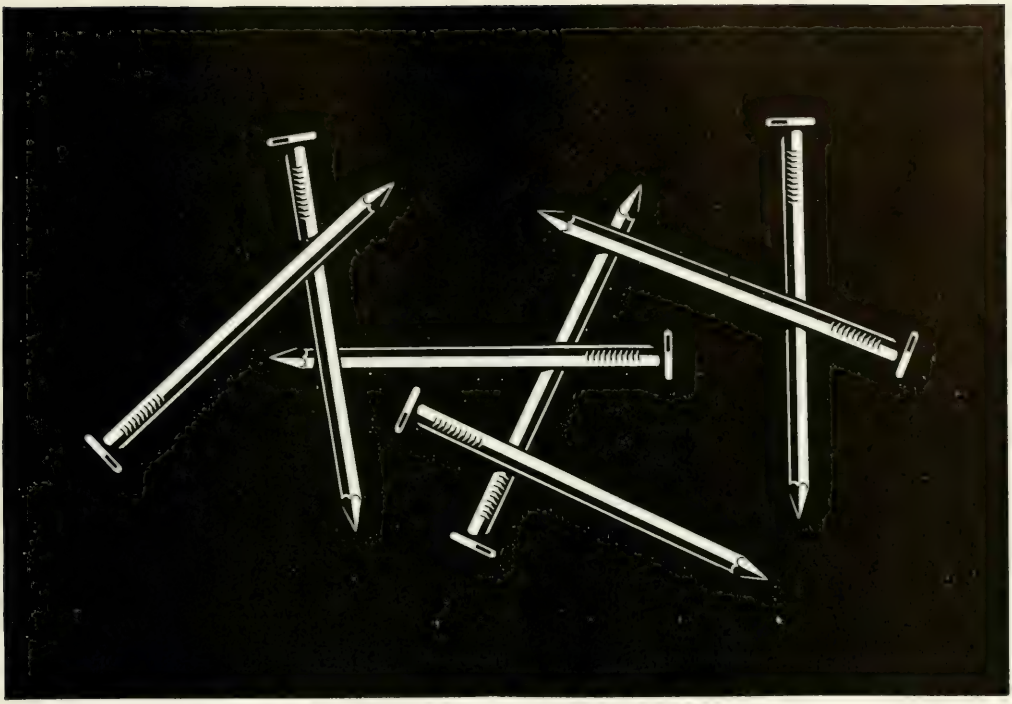

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PONTIAC

MOTOR DIVISION • PONTIAC, MICHIGAN

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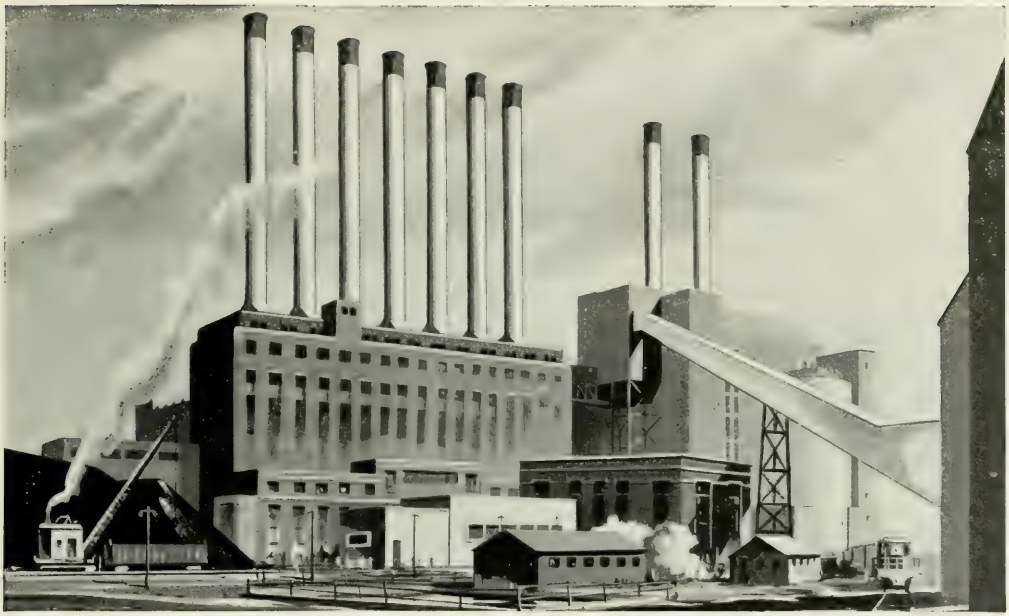


The two new stacks at the right of this artist's drawing of Detroit Edison's Conners Creek plant mark the addition of two new turbo-generators that increased the plant's capability to 582,000 kilowatts, and brought the system capability to 2,000,000 kilowatts.

Southeastern Michigan Grows on Firm Foundations

The population of Southeastern Michigan has grown to almost 3,500,000. Ever mindful of the need for keeping well ahead of Detroit's and Southeastern Michigan's growth, Detroit Edison continues with its never-ending expansion of power generating and distributing facilities.

Now, working together as one of industry's four atomic research teams, Detroit Edison and Dow Chemical Company engineers are investigating the use of nuclear heat in thermal electric generating plants . . . an investigation pointing toward better ways to provide electric power for the nation.

Edison's customers have confidence in the supplier of their electric power . . . confidence that whatever, whenever, wherever their power needs may be, Edison will fill them. And Detroit Edison, through its expansion program, is making certain that Southeastern Michigan will have a firm, dependable foundation for future growth.

The Detroit Edison Company

McDonnell . . .

Continued from page 15

McDonnell likes to fill vacancies by promoting men already with the company. To help the men help themselves, the company runs a training program for its employees. It also provides information on courses conducted by local schools and universities, and encourages employees to take advantage of them.

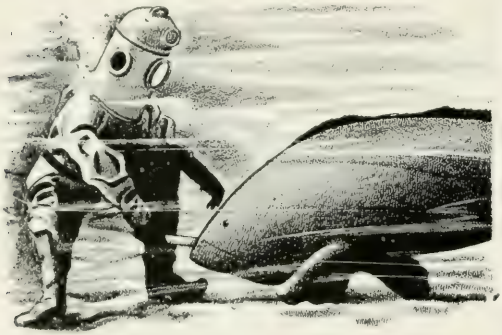
McDonnell is an informal place. The employees refer to "Mr. Mac" at all times. "Mr. Mac" returns the favor by personally making some announcements over the plant public address system.

Before the last war, the aircraft industry was unstable. For that reason, many persons would not accept jobs in it. Today, however, the industry is a stable one. Although some of the stability is due to defense needs, the airplane plays a much greater part in the civilian America of today than it formerly did. There is no change in the status of the industry in the predictable future.

The McDonnell employee has a secure future with the company. In addition to social security, which every worker earns, M.A.C. has set up its own retirement income plan. This retirement income plan is the type in which both employee and employer contribute. Group insurance, accident, disability, and hospitalization plans are also available to the M.A.C. employee. Of course, all employees receive paid vacations.

Today, there are not enough aeronautical engineers graduating from schools throughout the country to maintain the aircraft industry at its present rate. McDonnell, along with other major aircraft companies, has developed its own training program to convert electrical, civil, and mechanical engineers to aeronautical engineers. This on-the-job training is often more up to date than anything taught in the universities of the country. Engineers who are interested in airplanes could do well to consider the aircraft industry.

The new F2H-3 Banshee twin-jet returning from a test flight. This carrier-based fighter is equipped with the most modern type of radar, more powerful armament and increased internal fuel capacity.



The wonders of the ocean's floor are duplicated in two giant tanks at Marine Studios, at Marineland, Fla. More than 30,000 live undersea specimens are presented in their natural setting, and into these tanks are pumped more than 7,000,000 gallons of sea water per day.

Okolite-Okoprene cable was selected as the most reliable means of supplying power to the motors which pump this water. Power is taken from a 2300-volt circuit and stepped down to 220-110 volts, for motors ranging from $1\frac{1}{4}$ to 30 h.p.

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• • •

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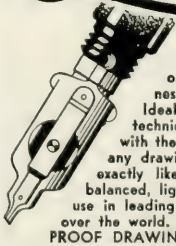

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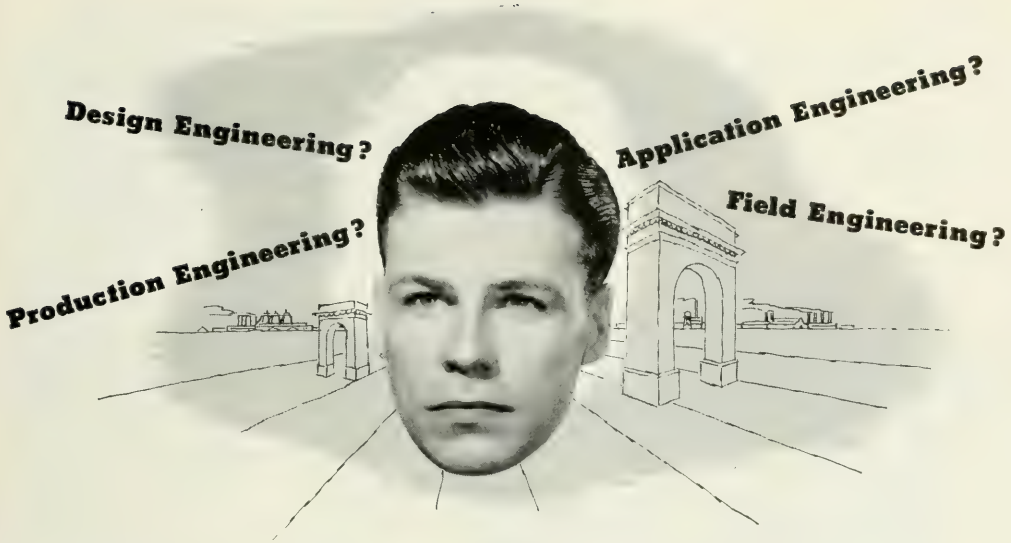

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Stable, essential industry: The products manufactured by Harvester are basic, essential products that pay for themselves in use. The farm equipment, trucks, industrial power, and refrigeration products bearing the Harvester name are essential to our economic well-being. *This kind of basic industry offers challenging careers to its employes.*

Job opportunities: Harvester has had steady growth; today it is an industrial leader. As such, it offers many fine and diversified job opportunities. Today, more than 90,000 people call Harvester their working home.

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How about advancement? There is no limit to advancement with this company. The president and eleven others of today's officers of International Harvester Company came up through the ranks. Encouragement is given the young person with ambition and ability. One's future can be excellent indeed with International Harvester.

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Chicago 1, Illinois

Builders of farm equipment for easier, more profitable farming . . . trucks for better transport . . . industrial power for road-building and earth-moving . . . refrigeration for better preservation of food.

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40,000 feet up, bucking the sonic barrier can be a "breath-taking" experience . . . one reason why jet pilots require medically pure Airco oxygen.

how low?

Down, down, 14,000 feet or more, to the oil-bearing depths, through rock and shale and abrasive sands . . . Airco hardfacing alloys "spearhead" the whirring bits of an oil well drill string.

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From supplying the vital breath of high altitude aviation . . . to toughening the drills that bore miles into the earth's crust — Air Reduction products span an incredible range of industrial applications!

Just review the requirements of American industry: from basic chemicals and gases . . . to the hand tools and precision machinery used to weld, cut and shape metal parts . . . in fields as remote as textiles and turboprops . . . you'll find the Air Reduction Company improving the products and processes of today . . . and contributing to the discoveries of tomorrow.

In fact, wherever progress is racing ahead to new frontiers, you'll find an *Air Reduction Product.*

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DIELECTRIC . . .

(Continued from page 12)

per batch may be found from the following relationship:

$T = .037 \frac{pt}{v}$ (v = volume) p = power in watts, which equals 1 min. This unit has a theoretical capacity of 120 bu. per hour. The actual capacity would be less than this due to the time used in filling and emptying the unit, although at the rate shown, a continuous flow could probably be set up.

This unit would merely serve to heat the corn without damage to the maximum temperature throughout, and the actual drying would be done by forced preheated air. This is feasible because the failing of the forced air systems at low moisture contents is due to the inability to heat the corn through evenly in order to get the excess moisture in the center of the kernel.

At a rate of 3 cents per kilowatt hour, the cost of the energy to heat the corn would only be $1.24 per bushel, so if the corn was not dried sufficiently the first time through, it could be recirculated and the cost would still remain very reasonable, considering that seed corn sells at about $10 per bushel.

While this seems logical, there are many "bugs" in the design yet. The dielectric constant, which was assumed above, is dependent on a great number of things, including moisture, temperature, pressure and frequency. The net result would indicate that the "constant" would vary with every batch and even within each batch. The specific heat also varies with the moisture and also with the fat content of the corn, which means that every variety would have a different value for specific heat.

Another of the large problems in this field is the design of a suitable power source. An oscillator that is capable of putting out 50kw at 20,000 volts and 20 megacycles is no small undertaking in itself. The initial cost of such a power supply must be reasonable, and it must have a long life expectancy to make the initial cost amortize to a reasonable amount.

The design of the electrodes to be used with this type of machine is another field that has yet to be explored thoroughly; the main problems being the ability to keep the material at uniform thickness and density and keeping the electrodes from becoming hot by conduction.

This is just a survey of the problems and uses of dielectric heating, which in time may become a very important process in many of our country's largest industries.

DROP TESTING . . .

(Continued from page 30)

for future study. Any parts that fail during a drop are removed, photographed, and analyzed so that a better design can be made. The re-designed parts are replaced and the tests continued.

Drop tests are made to simulate all the landing conditions that the airplane can experience to prove all elements of the alighting system. Among these conditions are:

(1) Three-point landing,
(2) nose-wheel-first landing,
(3) tail-wheel-first landing, and
(4) cross-wind landing (with its resulting high sideloads).

The drop test, although only one of many tests the airplane must undergo, is a necessary part of the aircraft manufacturing process. The high standards set by the aircraft industry of the United States, as manifested in excellence of design, have made us the leader in the progress of high-speed transportation.

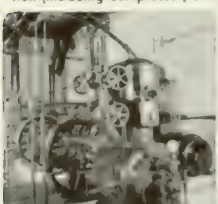
Frank: "Our waitress is pretty."
Hank: "Yes, but not very fetching."

SERVES THIS FINE NEW DAIRY PLANT

Crowley's Milk Company sells a dozen dairy products from its super-modern plant in Newburgh, New York. Here dependable Frick Refrigeration (including compressor, condenser, ice reserve unit, valves, controls, etc.) carries the entire cooling load. When lightning struck last summer, burning out electric starters, the Frick ice reserve unit saved every pound of product.

Put YOUR cooling problems — whether for air conditioning, ice-making, quick-freezing or other refrigeration work—up to Frick engineers.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.



Frick Ammonia Compressors at Crowley's Milk Company

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FRICK CO.
WAYNESBORO, PENNA. U.S.A.
Also Builders of Power Farming and Sawmill Machinery

A caller rang the bell of a doctor's home and the door was opened by his little boy. "Doctor home?" the caller inquired pleasantly.

"No, he isn't," was the answer. "He's out doing an appendectomy."

"My goodness," said the caller, "isn't that a mighty big word for a little boy like you? Do you know what it means?"

"Sure," said the boy. "$250."

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233)

Of The Illinois Technograph published January, February, March, April, May, October, November, December, at Urbana, Illinois for October 1, 1952.

1. The names and addresses of the publisher, editor, managing editor, and business managers are:
Publisher, Illini Publishing Company, Champaign, Illinois;
Editor, Allen O. Vejar, Danville, Illinois.
Business Manager, Eric P. Aagaard, Chicago, Illinois

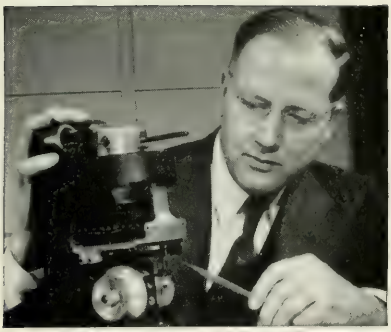
2. The owner is: the Illini Publishing Company, a non-profit corporation.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: none

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

Eric Aagaard, Business Manager.

Sworn to and subscribed before me this 20th day of October, 1952.
(SEAL) Margaret E. Cain
(My commission expires Jan. 2, 1955.)



DR. CLINTON R. HANNA, *Associate Director*
Westinghouse Research Laboratories
Enrolled in Westinghouse Graduate Student Training Course after graduation from Purdue University in 1922. Dr. Hanna, with over 100 patents to his credit, is one of the nation's leading authorities on gyroscopically controlled regulating devices.

CARROLL V. ROSEBERRY, *Manager*
Westinghouse Electric Utility Department
Upon graduation from Oklahoma A & M in 1934, he enrolled in the Westinghouse Graduate Student Training Program. Assigned first as a salesman, he was advanced to district Assistant Electric Utility Manager, branch Electric Utility Supervisor, and in 1951 was appointed to his present post.

DR. EDWIN L. HARDER
Westinghouse Consulting Engineer
Enrolled in Westinghouse Graduate Student Training Course after graduation from Cornell University in 1926. Dr. Harder has become nationally known for his analytical and development work in power systems. He is co-developer of the Anacom, an electric analogue computer.

They did what you can do to achieve success

These Westinghouse executives have several things in common . . . a desire to excel, intense enjoyment of their work, and early training in their fields of specialization. All entered Westinghouse through the Graduate Student Training Program . . . the same program that today is launching young engineers on careers with Westinghouse.

You can do what these men did to achieve success. They found out early what their likings and talents were, what they wanted to do, and set their sights accordingly. With the help of the Westinghouse Training Program, you, too, can get off to a sure start on the career of your choice.

The Westinghouse Graduate Student Training Program

This program has been carefully developed through 50 years to enable top men, selected in leading colleges, to choose their careers wisely from the wide variety of opportunities available at Westinghouse. The program gives you a clear understanding of the company and its products . . . lets you try out many types of work through planned work assignments . . . and offers you the benefit of personal counsel in selecting the field for your career. The Westinghouse Graduate Student Training Program helps supply the answer to that all-important question, "Which is the *right* career for you?"

For full information on the Westinghouse Training Program, send for our 32-page book, "Finding Your Place in Industry."
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EDUCATIONAL DEPARTMENT

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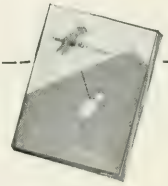

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There's something here somewhere about laying an egg...

ONCE UPON A TIME there were two farmers. Each had a hen that laid 20 eggs a month.

Both farmers liked eggs, so one ate his. But the other did without, and put his eggs in an incubator which he bought by borrowing money. In no time he had 200 chickens from his one. A shocking profit! (Before taxes.)

He sold some to pay down the loan on his incubator; he ate some as a reward for all his labor in raising the brood. And he sold a good many to pay his income tax.

He still had some left. Profit.

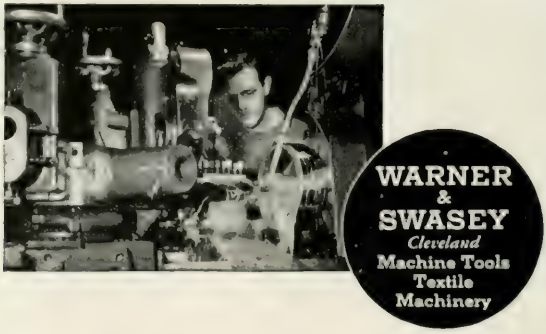
So the farmer who had eaten all his eggs got a law passed. The neighbors divided up the chicken-raising-farmer's "profits" and ate them. After all, they said, he had more than he needed, and they were hungry.

So, of course, the farmer wasn't going to raise any more chickens just to have them taken away from him; he ate his eggs, too.

In due time both the farmers' original hens died of old age, and then there weren't any eggs for anybody. No chickens either.

The neighbors were quite sure it was somehow the chicken raiser's fault.

Did the farmer, who used to eat all his eggs, enjoy his now-eggless meals any more for realizing that the farmer next door wasn't enjoying any chicken?



YOU CAN MACHINE IT BETTER, FASTER, FOR LESS WITH WARNER & SWASEY TURRET LATHES, AUTOMATICS, AND TAPPING MACHINES

THE DU PONT DIGEST

Production for M.E.'s

Du Pont's manufacturing side offers opportunity to mechanical engineers

The young mechanical engineer interested in production finds plenty of opportunity at Du Pont. His skills are in great demand because so many of this Company's products are made in equipment which must operate continuously on automatic controls.

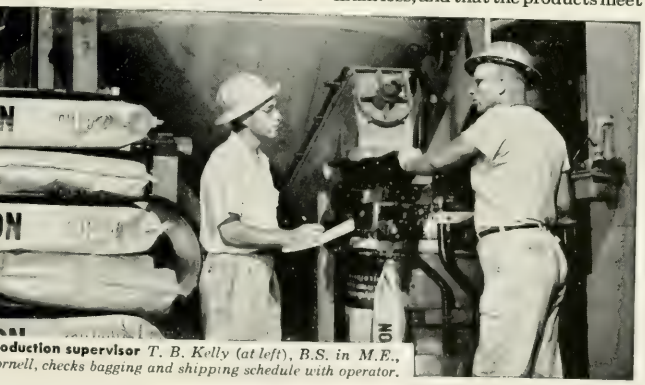
More than half of Du Pont's M.E.'s are currently engaged in some phase of production work. There are three main categories.

1. MAINTENANCE SUPERVISION. Resourcefulness and initiative are needed in men selected for this work. Among their many duties are the scheduling of preventive maintenance and emergency repairs to minimize down time, suggesting equipment improvements to reduce the maintenance load, and estimating costs of changes or major repairs.

Normally, the supervisor establishes maintenance procedures, directs transfer of personnel from one group or area to another, and assigns duties. He sets up office and field work methods and controls the supplies of spare parts and stores.

The importance of this work is emphasized in some Du Pont plants where more men are needed to maintain the equipment than to operate it. At one plant, the division maintenance superintendent, a man with several years experience behind him, is responsible for 1,500 pieces of equipment and 100 miles of pipe. He has 120 men under him, including 10 foremen.

2. PRODUCTION SUPERVISION. Other mechanical engineers at Du Pont use their knowledge of mechanical equipment in solving production problems. They must see that raw materials are on hand, that maximum yields are obtained with minimum loss, and that the products meet rigid specifications. In addition, they must train men in proper equipment operation and maintain good personnel relations.



Production supervisor *T. B. Kelly (at left), B.S. in M.E., Cornell, checks bagging and shipping schedule with operator.*

J. D. McHugh *(at right), B.S. in M.E., Rochester '50, and draftsman discuss working drawings for plant equipment improvement.*

One area supervisor, also an experienced man, usually has charge of from 125 to 150 people, including 6 to 10 foremen.

Keeping compressors *in top running condition is a typical maintenance-group problem.*

3. PLANT TECHNICAL. Other M.E.'s at Du Pont are assigned to the teams of plant technical men responsible for process and production improvements. In this work, they help solve problems on machine design, strength of materials, control instruments, packing materials for high-pressure equipment, etc.

Actually—in maintenance, production and development—the possibilities are almost unlimited at Du Pont for the M.E. who likes the manufacturing side of industry.

HAVE YOU seen "Mechanical Engineers at Du Pont"? 32 pages of facts about opportunities for mechanical engineers. For copy, write: 2521 Nemours Building, Wilmington, Delaware.

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150th Anniversary
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HUMAN ENGR. . . .

(Continued from page 10)

aircraft must be so arranged as to allow the pilot to instantaneously check his flight altitude while in the traffic pattern and taking instructions from the traffic control tower.

Laboratory work with air traffic conditions is carried on with a simulator, which is a tower; seventeen simulated aircraft, and two link trainers. With this simulator traffic control problems are worked out with various instrument displays under different conditions.

Along with the simulator, used for instrument display research, other synthetic flight trainers are used in the laboratory. Much work is devoted to the characteristics of synthetic flight trainers.

The major problem with which the laboratory is concerned is how faithfully the synthetic flight trainer should simulate the characteristics of actual flight. A closer simulation of flight characteristics can be obtained at greater costs, but the increased costs cannot be justified after a certain optimum point in simulation is reached. A study of control pressures is conducted as a part of the program to determine the necessary degree of simulation to actual flight controls. Results of the study showed that control pressures of synthetic flight trainers need not simulate actual flight control pressures at all closely.

The laboratory is also engaged in a study of synthetic flight trainers to determine how to use these trainers to teach a greater variety of maneuvers, thus reducing the extra time and expense of teaching these maneuvers in actual flight training. In connection with this, a special trainer display for landing approaches is being studied in the laboratory.

With respect to navigation displays, the laboratory has conducted studies concerning various displays of omni-directional range (VOR) and distance measuring equipment (DME). One of the main parts of the study is a comparison of the symbolic instrument display, by which the pilot determines his relative position from the information presented by the instruments in the display, and the pictorial display. The pictorial display, instead of using the conventional instruments, shows the relative position of the aircraft by means of a pip superimposed on a navigation map. The pictorial display eliminates much of the computation needed to determine position from the conventional instruments and it is possible with this type of display to instantaneously check relative position without any checking of instruments. These pictorial displays have been built but they pose many problems due to cost, space requirements and insufficient research and testing at this time.

A major experiment is the use of a projection type periscope as a navigation aid. In 1946 and 1947 the laboratory experimented with a periscope which provided an image of what lay ahead of the aircraft to see if it could be used in flight instead of contact visibility or instrument flight. Although the first model was rather crude, successful landing could be made with it. The landings with the first model were not as accurate as those made with contact visibility, but the fact that successful flights could be made provided encouragement. Further experiments were carried on to try to improve the periscope and find the optimum image magnification and angles of outside visibility.

The periscope could be used as a navigation instrument to show the pilot where he is going, but its main purpose is to serve as a flight instrument by which the pilot may control his aircraft. To perform these experiments, several pilots flew a plane equipped with the periscope and executed various maneuvers, including landings, under different magnifications and angles of outside vision. From these experimental flights, it was determined what effect the periscope had on the ability of the pilot to control his aircraft, and what magnification and angle of visibility produced flight characteristics most like contact visibility flight. A detailed explanation of the early periscope display experiments is given in the Institute of Aviation Bulletin Number Nine "Flight by Periscope." Other bulletins from the laboratory are Institute of Aviation Bulletin Five "Evaluation of the School Link as an Aid in Primary Flight instruction," and Bulletin Eight "Evaluation of the School and Special Methods of Instruction in a Ten-Hour Private Pilot Flight-Training Program."

Two engineers were on a bus to town when Joe noticed that Dave had his eyes closed.

"What's wrong, Dave, feeling sick?"

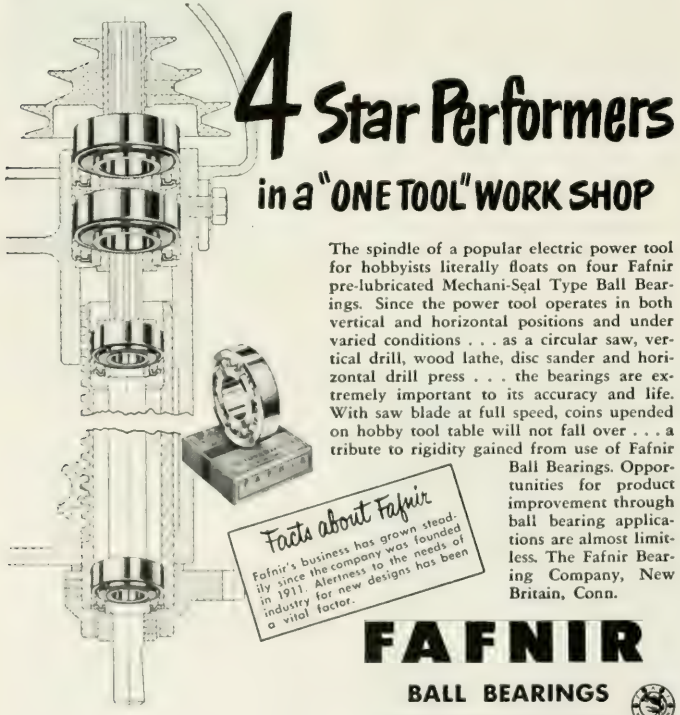
"I'm O.K. It's just that I hate to see women standing."

* * *

Dutch: "Hey, rabbit, what are you doing in my ice box?"

Live Rabbit: "Ain't this a Westinghouse?"

Rabbit: "Well, I'm westing."



4 Star Performers in a "ONE TOOL" WORK SHOP

The spindle of a popular electric power tool for hobbyists literally floats on four Fafnir pre-lubricated Mechani-Seal Type Ball Bearings. Since the power tool operates in both vertical and horizontal positions and under varied conditions . . . as a circular saw, vertical drill, wood lathe, disc sander and horizontal drill press . . . the bearings are extremely important to its accuracy and life. With saw blade at full speed, coins upended on hobby tool table will not fall over . . . a tribute to rigidity gained from use of Fafnir Ball Bearings. Opportunities for product improvement through ball bearing applications are almost limitless. The Fafnir Bearing Company, New Britain, Conn.

Facts about Fafnir

Fafnir's business has grown steadily since the company was founded in 1911. Alertness to the needs of industry for new designs has been a vital factor.

FAFNIR

BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

The practically solid gear lubricant used in diesel locomotives and the thin, soft lubricant used in a station clock are as different as are the two mechanisms. Yet both are greases—products of research that has developed thousands of other special greases.

It takes more than elbow grease to make the world go 'round!

So different in other ways, the locomotive and the silent electric clock have in common one absolute essential: grease—a special grease for each mechanism.

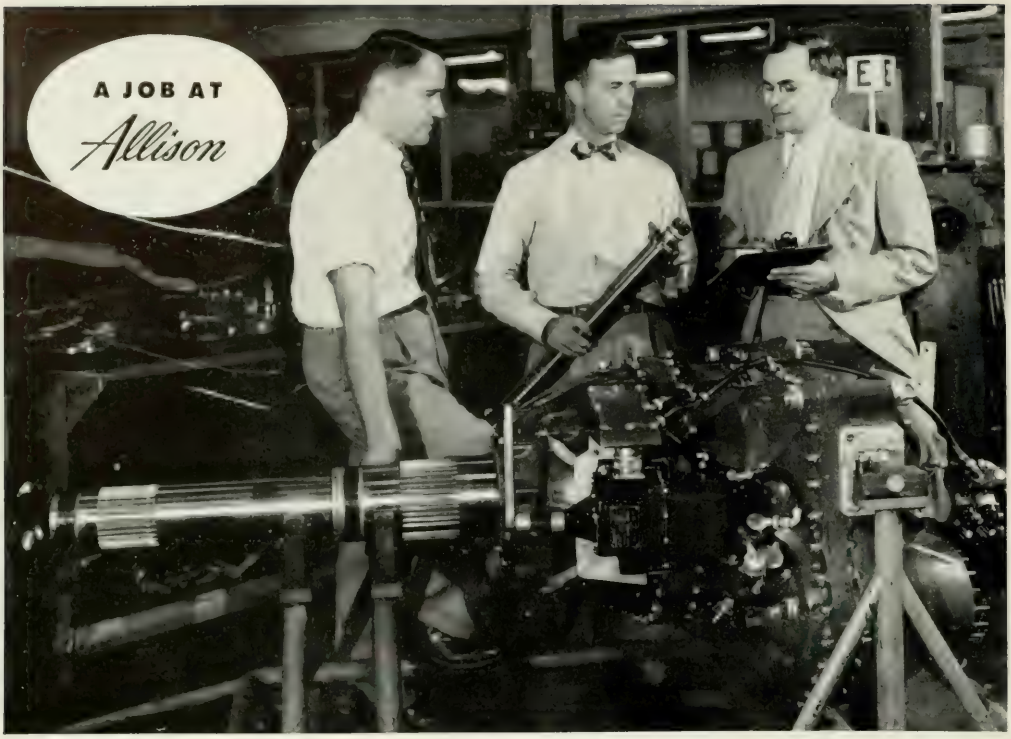
And this merely hints at the wide range of needs. Coke-oven grease must stand temperatures of 600° F. Airplane grease must lubricate at both desert heat and sub-zero cold. Stamping compounds keep metal from welding to dies. Naval greases prevent corrosion by salt spray. Almost any kind of machinery embodies its own special lubrication challenge.

Chemists and engineers apply their knowledge, experience, and imagination to finding successful answers. Such research holds a wealth of interest and satisfaction for young technical men at Standard Oil.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD



Left to right—C. Mead Hawkins, U. of Toledo, B.S., Mechanical Engineering 1948, M. H. Thomas, Kansas State College, B.S., Mechanical Engineering 1939 and V. W. Peterson, B.S., Mechanical Engineering, Rose Polytechnic Institute.

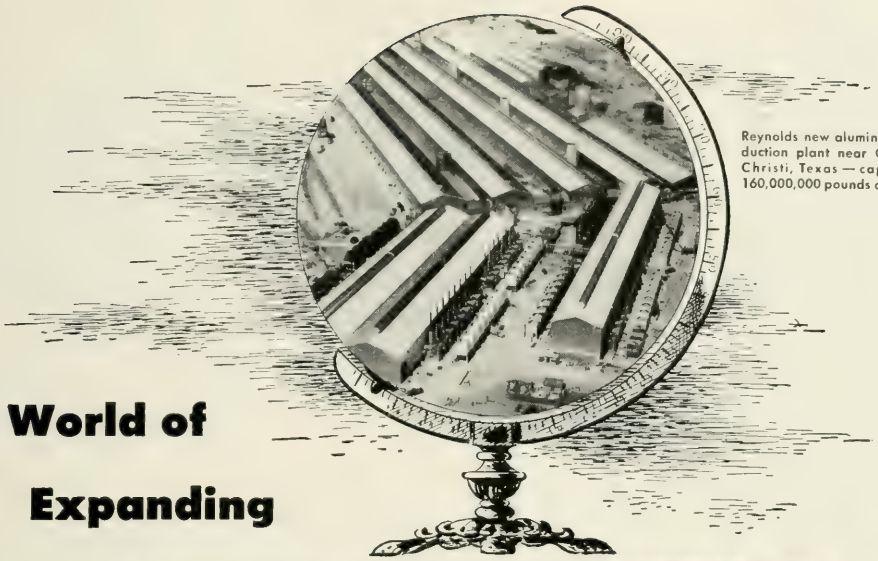
● V. W. (Pete) Peterson, who was graduated from Rose Polytechnic Institute in 1939, is one of the modern day pioneers in the design of jet and turbo prop engines. His particular job is to supervise a group of engineers responsible for the basic detail design of reduction gear boxes and extension shaft systems for Allison Turbo-Prop Aircraft Engines.

Each engine consists of a pair of turbine power sections which revolve at more than 14,000 r.p.m. Two extension shafts transmit this high rotative speed to a gear box which reduces the shaft speed in the order of 16 to 1 to drive two contra-rotating co-axial propellers. Some airplane installations require extension shafts as much as 14 feet long. Thus, the problem is more than harnessing the engine output of 5500 horsepower to a propeller. The long shafts, rotating at high speeds, must be delicately balanced with flexible bearing mounts so they will not set up destructive vibration even though they are subject to many kinds of bending and twisting motions through various attitudes of flight.

This is another of the interesting problems at Allison which represent a challenge and an opportunity for young engineers. Every day men at Allison are making a new contribution to the science of jet engines. And, at the same time they are adding to their own experience in a field which offers life-time careers for qualified young men.

Allison **DIVISION, GENERAL MOTORS CORPORATION • Indianapolis, Ind.**

Design, development and production—high power TURBINE ENGINES for modern aircraft . . . heavy duty TRANSMISSIONS for Ordnance and Commercial vehicles . . . DIESEL LOCOMOTIVE PARTS . . . PRECISION BEARINGS for aircraft, Diesel locomotives and special application.



Reynolds new aluminum reduction plant near Corpus Christi, Texas — capacity 160,000,000 pounds a year.

A World of Expanding Opportunity!

In a land noted for rapid expansion of free industrial enterprise, few companies have matched the swift and continuing growth of the Reynolds Metals Company. Now operating 27 plants in 13 states, and still expanding, Reynolds offers the ambitious engineering graduate a world of opportunity.

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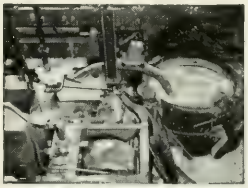
On-the-job training is the Reynolds policy—after preliminary orientation which may include basic experience in production plants for sales personnel, and sales office work for technical trainees. Liberal insurance, hospitalization and retirement programs are maintained.

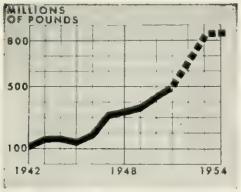
For important background information on "your future in Aluminum," *mail the coupon.* If you are definitely interested now, write direct to General Employment Manager, Reynolds Metals Company, 3rd and Grace Streets, Richmond 19, Va.



Tapping one of huge battery of electrolytic cells

Sheet rolling—reverse hot mill in operation

REYNOLDS ALUMINUM



Reynolds expanding production — historic chapter in 33 years of continuing growth.

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Please send me, **FREE,** your 96-page booklet, "The ABC's of Aluminum"; also the 44-page book, "Reynolds Aluminum . . . and the Company that makes it."

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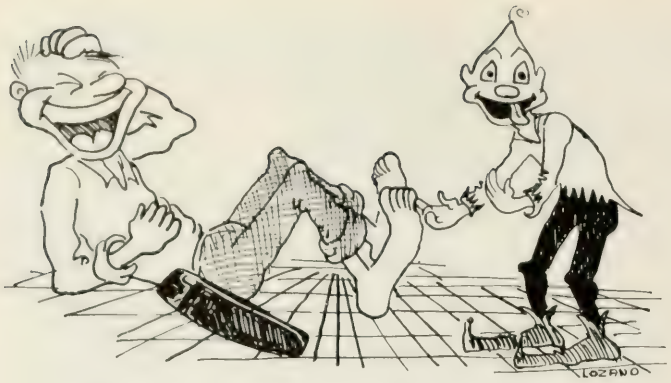

TECHNOCRACKS

by Peter Cattapan, Gen. E., '53

Do you think our jokes are corny, old, reprints, or just plain lousy? Well, believe me we try to get the best and funniest jokes possible. Here is how your humble thermo. T.A.M. -, and slide rule-minded reporter got this month's jokes.

After much research your reporter found himself in the office of Mr. Joseph J. Finn, vice-president of Reincke, Meyer and Finn Advertising Company, a world-famous advertising firm on North Michigan Avenue in Chicago. Mr. Finn was the originator of placing humor on the back of transfers for the Chicago Transit Authority (the public transportation system in Chicago). Mr. R. Budd, Chairman of the Board for the Chicago Transit Authority, and a personal friend of Mr. Finn, carried out the suggestion.

To insure the 1,500,000 users of the transfers with good jokes, the Chicago Transfer Ads Company has a large rotating group of judges that select the jokes. Nine judges, all of whom have different backgrounds, read from twenty to thirty jokes at any one time. The jokes are received from three professional humor writers and from numerous contributors. If any two of the nine judges do not find a joke humorous, the joke is discarded.

This procedure of getting and selecting good humor is the best that this reporter has been able to find.

We would like to thank Mr. J. J. Finn and the Chicago Transit Authority for the story and the following samples of their jokes.

"I hear your son has his B.A. and his M.A."

"Yes, but he's still living on his P.A."

Voice on 'phone: "Are you the desk clerk?"

Desk Clerk: "Yes, what's eating you?"

Voice: "That's what I'd like to know."

* * *

Maid: "The furniture installment man is here again, ma'am."

Madam: (resignedly) "Tell him to take a chair."

* * *

Nephew, at bedside of rich uncle: "Is there no hope, Doctor?"

Doctor: "I don't know. What were you hoping for?"

* * *

Stern parent: "Young man, you want to marry Mildred? Can you support a family?"

Suitor: "No-o-o. But I want to marry Milly."

* * *

Boss: "Are you sure your wife knows you're bringing me home to dinner?"

Bob: "Does she know? We argued about it for half an hour this morning!"

* * *

Hotel Clerk: "Have you a reservation?"

Guest: "No. Do I look like an Indian?"

* * *

"My wife doesn't understand me. Does yours?"

"I don't know—she never mentions you."

* * *

"Your neighbors do a lot of borrowing, don't they?"

"Yes, now we feel more at home in their house than in ours."

Customer: "I want two tickets in the coolest part of the theatre."

Clerk: "Okay—here's a pair in Z row!"

* * *

"Why did you punch yourself in the jaw?"

"Well, I was so bored I got to talking to myself—and I can't stand a liar!"

* * *

Wife: "So you were sitting up with George because he was sick. I suppose you held his hand all night!"

Husband: "Wish I had—I'd have made some money!"

* * *

Dill: "I have a terrible conscience."

Gill: "What's wrong with it?"

Dill: "It doesn't keep me from doing things—it just keeps me from enjoying them."

* * *

Customer: "I'd like to buy a bottle of reducing medicine."

Druggist: "Anti-fat?"

Customer: "No, for my uncle."

* * *

She: "I know nothing but good of Alice."

Other She: "Then let's talk about someone else."

* * *

"Can you serve company?" asked the housewife when she was hiring the new maid.

"Yes, mum; both ways—so's they'll come again—or stay away."

* * *

"My father always proposed a toast before he disciplined me."

"That's funny! What was it?"

"Bottoms up."

* * *

TACT is what makes a man shut his mouth before he puts his foot in it.

* * *

Son: "Since leaving college, I've worked hard, trying to get ahead."

Father: "Well, you could use one!"

* * *

Traffic Cop: "Didn't you hear my whistle?"

Girl Driver: "Yes, but you're too late. I'm engaged!"

* * *

"So Murphy and Sweeney were hitting each other with chairs? Why didn't you make peace between them?"

"No more chairs!"

* * *

Friend: What is your son going to be when he passes his final exam?

Father: An old man.

illinois
technograph
Season's Greetings
.25
1957

There's been a cold war on in Minnesota lately

. . . And our metallurgists have won it.

Up in the iron ore range, where 40 below zero can be expected frequently, shovel operators usually plan their operations to remove a year's supply of ore during warm weather months when the ore is workable. But recently, with steel requirements ever increasing, shovel operators began working around-the-calendar.

And they ran into trouble.

During one cold spell when the temperature dropped to 40° below throughout the iron ore range, the ore froze solid. The extreme cold caused steel in the equipment to lose some of its toughness, and power shovel booms and dipper sticks broke all over the range as the huge steel dippers were rammed into the frozen ore with tremendous force.

But there was one significant exception. Operators using shovels with booms and dipper sticks made of one particular steel went right on gouging up frozen ore without any equipment trouble.

Those shovels stood up because the heavily stressed parts were made from U·S·S TRI-TEN—a remarkably strong steel that has a high degree of toughness, even at low temperatures.

Moreover, the users were able to cut the weight of their TRI-TEN parts by 25%, even though some working stresses were increased 50%. "And," says one shovel manufacturer, "TRI-TEN steel has enabled our customers to operate this equipment successfully at temperatures as low as —45 F."

• • •

U·S·S TRI-TEN is only one of hundreds of steel compositions developed by United States Steel to meet special service conditions. Trained U. S. Steel metallurgists work with manufacturers all over the country to help solve problems involving the more efficient use of steel. United States Steel Company, 525 William Penn Place, Pittsburgh 30, Pa.

USS

2-1942

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the illinois technograph

volume 68 **number 3**

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our cover

The members of the "Tech" staff send Christmas greetings to you, our friends, during this holiday season. We believe that this scene of the beautiful Illini Union building after a light snowfall is a pleasant reminder of many happy hours at the University. We wish success in all your endeavors, good luck and a bright, prosperous New Year. (Photo courtesy A. R. Wildhagen)

our frontispiece

The nuclear physicist requires enormous amounts of electrical energy in his processes. The dramatic Reclamation Bureau photograph shows the magnificent Grand Coulee dam on the Columbia River in Washington. The Hanford Works of the Atomic Energy Commission is located near this dam in order to take advantage of its enormous power output. (Cut courtesy Westinghouse)

physics research via . . .

ELECTRONICS

by Robert Hardin, E.E., '54

The field of physics is a very broad one which can be sub-divided into many more specialized fields. Among these are mechanics, light, heat, sound, electricity and magnetism, nuclear, and solid state physics. Electricity has a very important role in the work of a physicist. In nearly all phases of physics research, use is made of very highly specialized electronic circuitry, which, in many cases, must be designed by the physicist himself for his special purpose.

And to enable the future physicist to design such apparatus, the Physics Department at the University of Illinois offers several courses in electricity and electronic circuits — courses far more advanced than the basic course in electricity and magnetism required for all engineering students. Juniors enrolled in the physics curriculum take a full year of electricity and magnetism, a course devoted to fundamental laws developed in Maxwell's equations, electromagnetic waves, boundary conditions, and radiation. Also in the curriculum for juniors, is a course in circuit analysis offered by the Electrical Engineering Department, E.E. 320. This is followed by another year studying vacuum tube circuits, amplifiers of all types, pulse techniques, counting and analyzer circuits—all with emphasis on experimental techniques used in research in physics.

In the Graduate College, too, the physics student continues this study of electronics. Offered are courses in the conduction of electricity in metals, insulators, and semi-conductors, and transistor electronics, a full year of electro-dynamics, and another laboratory course in which the student is largely concerned with the design and use of electrical apparatus necessary for carrying out physics research.

Two of the most important applications of electronics in physics research at the University are the cyclotron and the betatron.

The University of Illinois betatron is pictured in greater detail on pages 32-33 of this issue of the *Technograph*.

In the Nuclear Radiations Laboratory, located behind the Mechanical Engineering Building, is housed a sizeable collection of specialized electronic apparatus used in conjunction with the department's cyclotron. The chief use of the cyclotron is in nuclear physics research, proving or disproving theories on the behavior of nuclear particles.

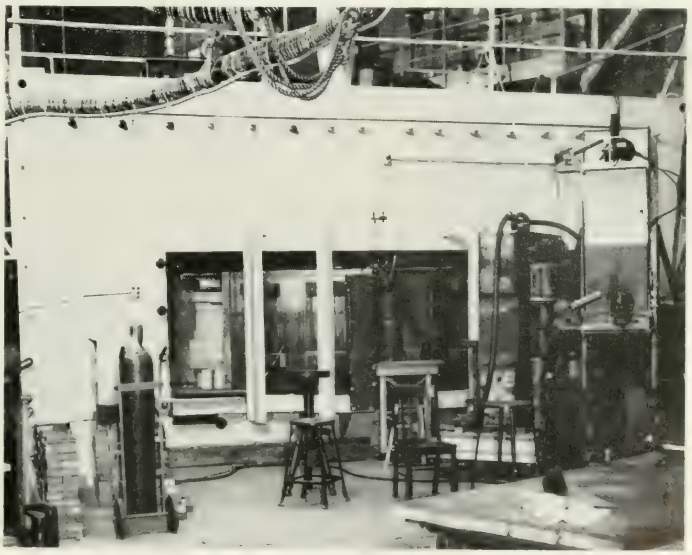
The dees of the cyclotron are supplied with 100,000 volts r.f. by a 12 mc. oscillator. A magnetic field of approximately 16,000 gauss is supplied by a motor generator set operating at 350 amperes. The ion source in the cyclotron is a gas discharge tube which expels deuterons into the dense magnetic field. These deuterons are accelerated in spirals and after 150 revolutions in the cyclotron, they leave with a velocity of 30 million meters per second. The beam current, made up of these particles, is about 20 microamperes.

After leaving the cyclotron, the particles go through a magnetic analyzer and are channeled through a water wall (the latter for shielding equipment and personnel) before reaching the experimental apparatus.

The experimental apparatus consists of the target, which the particles strike at high speeds, causing a nuclear reaction. The target then gives off reaction particles which are to be studied. These reaction particles, or nuclear particles, strike a scintillation crystal, lose their energy to the crystal, and the crystal in turn, gives off light. This light is changed to electrical pulses and amplified by a multiplier phototube and a pulse amplifier.

The multiplier phototube used was

Continued on page 48)



One of the physicist's chief research tools, the betatron. Above is the University's 320 million electron volt betatron.

the Technograph features the . . .

PHYSICS DEPARTMENT— ENGINEERING PHYSICS

by Tom Madden, Gen. E., '54

In the early dawn of a July morning in 1945, a tremendous flash of light streaked across the sky at Alamogordo, New Mexico. This light was the result of the explosion of the world's first atomic bomb on White Sands Proving Ground, some sixty miles southwest of Alamogordo. For the first time in history a terrific amount of concentrated power was released from the atom—building block of the universe. So great was this power that the desert sand was melted to glass over an area nearly one-half mile wide. Today the United States is manufacturing bombs many times the potency of that first test bomb, and is applying atomic energy research to projects such as power plants, aircraft, and submarines.

Thousands of physicists worked on research teams contributing to that final atomic bomb which was tested in 1945, and which has been improved many fold since. Some of these men graduated from the Engineering Physics curriculum here at the University of Illinois. Nuclear physics is by no means the only field this study course trains students for; in fact, a relatively small percentage of those graduating from the curriculum enter this type of work. Nevertheless, Engineering Physics provides the undergraduate courses needed to proceed through graduate work into the nuclear physics field.

Looking briefly into the history of Engineering Physics, we find that it is a relatively new curriculum, having been established in 1917. The idea for such a study course was brought forth by two engineering students in 1914 who desired to specialize in physics rather than one of the basic engineering curriculums such as mechanical or civil. These students did not have their request granted, but their inquiry served to start discussion on the possibility of allowing engineering students to major in physics. Three years later the curriculum was formally established and the first student was graduated in 1923. Since the time of its inauguration, the trend in Engineering Physics has been toward more physics and electives, with fewer of the standard engineering subjects required.

Although the College of Engineering has the final decision concerning any change of courses included in the curriculum, the Physics Department has its own committee to draw up the list of course requirements. This list is then sent to the Engineering College and, subject to its approval, is enacted the following year. Under this system the Engineering Physics curriculum is actually managed and co-ordinated by the Physics Department. Doctors A. O. Hanson and C. P. Slichter are the program advisors in the Physics Department.

Engineering Physics is more of a pure science type of course than the other engineering curriculums. For this reason the requirements to be met, in order that the training received be valuable upon graduation, are quite rigid. A 3.5 grade point average is required and it is known as the hardest curriculum in the Engineering College. After graduation, the student should be equipped to handle problems in mechanics dealing with Legrangian equations, problems in electricity and magnetism demanding Maxwell's equations, A. C. circuit analysis and general circuit theory, and also in light, physical and geometric optics including the electromagnetic theory of radiation. This curriculum is unlike others in engineering in that no specific option can be selected and followed. However, one of the outstanding features of the course is the large number of elective hours allowed. Up to twenty-nine hours of approved and ten hours of technical electives may be selected. This permits the student to follow some other engineering field if he wishes, or he may choose to receive a broad education by including many non-technical courses. The first two years of Engineering Physics are very similar to all engineering curricula. In the last two years advanced courses in physics, mathematics, and chemistry are emphasized. As a junior, the student enters the 300 series of physics courses which are quite demanding, and soon "the men are separated from the boys." A look into the records reveals that over the years more than 50% of the students enrolled have

The Physics Building, which contains some of the most modern research equipment, is located on Engineering Campus.

attained better than a B average, which leads to stiff competition within the course. The grade and course requirements were not established to discourage the student, but merely to protect him against unemployment upon graduation. Good physicists are very much in demand, but poor ones find it very difficult to obtain employment, especially in normal times. The physicist does not receive specialized training as the normal engineer does, and is consequently required to be thoroughly trained in many fields.

Opportunities after Graduation

Upon completion of the Engineering Physics curriculum, one of three plans may be followed by the graduate. First he may, as the majority do, enter industry directly. Many men of this status are hired by large manufacturing concerns for technical work in widely varied fields. General Electric, Westinghouse, DuPont, General Motors, and similar plants employ physicists both for peacetime industry and government research work.

Second, the graduate may continue his education in graduate school for a master's or doctor's (Ph.D.) degree. This student usually follows an undergraduate course loaded heavily with physics and mathematics to prepare him for advanced schooling. The most lucrative fields of employment avail themselves to the graduate student when he finishes his one to three years of extra education. He may enter industry as a research physicist or work in a government laboratory on atomic energy, rockets, or Bureau of Standards tests. If the graduate does not care for the above type of work he may take a teaching position in a college or university. In large institutions he may be allowed to devote a great deal of his time to active research of his own choosing, while in small schools classroom teaching is of major importance. The shortage of physicists in this group is very acute, with three or four jobs available for each man entering the field.

The last plan available for the engineering Physics student is classified as miscellaneous and includes men who enter jobs where they do not use their training directly. Examples of this are employment in sales, management, production, and other comparable fields. A survey conducted in 1943 showed that students, upon graduation from the curriculum, continued their education as follows:

11% went on to complete Ph.d.
27% went on to complete masters degree
62% took jobs immediately

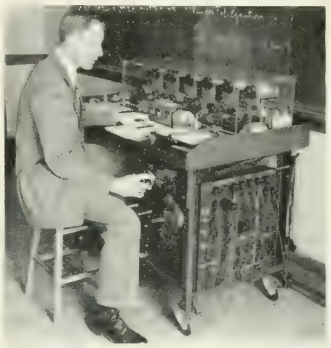
All students with a B.S., M.S., or Ph.d. were placed in occupations according to the following percentages:

14% in government work
13% in teaching
7% in the armed forces
66% in industry

Enrollment in Engineering Physics is quite small compared to the other curriculums. At the present time 103 students are studying the course at one or another of its four class levels. This represents quite an increase over last year, when only 86 were enrolled.

Facilities

The facilities of the Physics Department include structures on three different sites which house some of the most modern and complete equipment in the United States. In the Physics Laboratory building on the corner of Green and Mathews is located the department



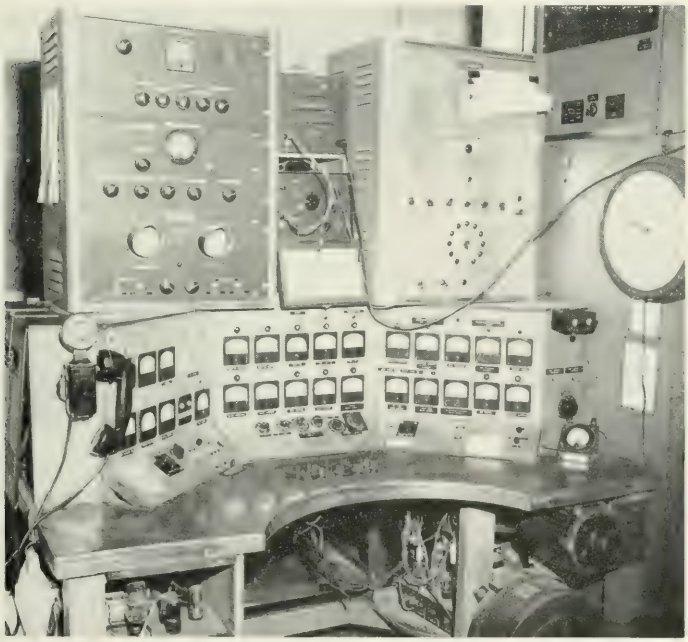
Professor Arnold T. Nordsieck with the Department's Differential Analyzer.

office. Also in this building are classrooms, undergraduate laboratories, a lecture hall, library, and other facilities used for demonstrations and research work. Among the facilities in the Physics Building are pieces of equipment used for investigations in magnetism, magnetic and electrical measurements, spectroscopy, phenomena at very low temperatures, and optics. Gas, direct and alternating current at several voltages, distilled water, compressed air, and liquid air are available. Nearly all research equipment of a specialized nature is constructed in this building.

The Nuclear Radiation and Cyclotron Laboratories, located on Goodwin Street, house radium sources and the University's 12 million electron volt cyclotron. The new Physics Research Laboratory is located on south campus near the Illinois Central Tracks. This building, better known as the Betatron Lab, houses three working betatrons ranging in size from 22 to 340 million electron volts.

Activities in physics can, with few exceptions, be divided into two major

(Continued on page 31)



A view of the control panel which is used to operate one of the University's Cyclotrons.

BEST E. C. M. A. ARTICLE OF THE MONTH

TRANSISTORS

by George B. Morgan, B.S., E.E., '52, University of Kentucky

Transistors as electrical elements have only recently come into their own in the engineering field. However, in the three years since their conception, by J. Bardeen, W. H. Brattain, and W. Shockley of the Bell Telephone System's laboratories, numerous papers have been written on transistors, the theory of conduction in the semi-conducting material of which they are made, and the processes of obtaining the various crystal characteristics.

The British have followed the development very closely with some additional work of their own. They have preferred to call the element the crystal triode.

The name transistors which is applied to the semi-conductor amplifier triode is derived from the prefix 'trans' which designates the transitory property of the device and 'istor' which is a root word applied to solid circuit element.

The transistor as such was introduced to the public on June 30, 1948, by Brattain and Bardeen, who made the discovery while studying the surface states of crystals. Their first work was on what is now called the type A transistor and was avery unstable element. However the work with semi-conductors is not particularly new. As early as 1925, Lilienfied patented semi-conducting devices. And during the last war the crystal diode was developed and used in many places to replace the thermionic diode.

In the order that the working of the transistor can be more clearly understood it will be necessary to look briefly at the physical background of semi-conductors. With reference to electricity, all physical matter can be classified into three groups; c o n d u c t o r s, semi-conductors and insulators. Conduction usually takes place in metals and occurs in metals that have one valence electron, i.e.; one electron in the outer shell that is free to move. Conductance decreases as temperature increases. Conduction in semi-conductors is achieved to a large extent from the electrons in the impurities present in the semi-conducting material. The electrons in a semi-conducting material usually are not free to move easily and tend to form pair bonds. The conductivity varies with temperature according to the following pattern. The conductivity will be increased with the first heat applied due to the increased energy available and then will tend to decrease due to lattice vibration and finally, if more heat is applied, the conductivity will increase again largely due to the excitation of carriers from the valence bond. To be a little more specific, conduction in the semi-conducting material is carried out by two methods; (1) electron flow or n type conduction and (2) hole flow or p type conduction. These two methods can be most easily understood by processes described in terms of energy bonds. First consider the conducting material; the energy level must be raised a distance x (work function) in order that the electrons can flow or conduct.

F fermi level or energy at O A

X work function — energy necessary for electrons to escape.

In the n type semi-conductor most electrons in the conduction band are derived from impurities, the impurities supplying them are called donor atoms.

C B conduction band (normally nearly empty)

V B B valence bond band

F termi level

Note: No free electrons are believed to occur between bands.

That is, conduction by electrons in semi conductors must take place in the conduction band with a suitable

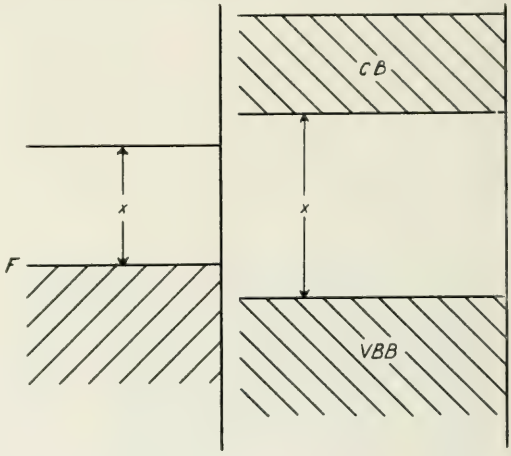


Fig 1 Fig 2

energy level and with the semi-conducting material at a negative potential, in order that the donor atoms will free the electrons.

In the p type or positive hole, conduction is achieved by 'holes' having energies near the upper part of the valence bond band. The 'hole' which acts as a positive charge can be assumed to be caused by the absence of an electron. The electrons are taken up by impurities to form ions and are called 'acceptors.' The 'holes' seem to be free to drift in semi-conductors and move in the direction of decreasing potential; that is from positive to negative.

Most semi-conductors used today are either germanium or silicon, with germanium being used most. The type n or p can now be determined by the heat treatment used.

It will probably be best to describe the method of obtaining the different types of crystals before explaining their use in transistors.

H. C. Theuerer and J. H. Scaff have conducted experiments which show clearly the effects of heat treatment on the electrical properties of germanium. The heat treatment enables the type to be reversibly controlled, from n to p and

back, etc. The results can best be interpreted in terms of change in donors acceptor balance. Since the conductivity depends upon the kind and quantities of impurities present, the germanium is first purified and then the desirable impurities added. Elements from the third and fifth periodic group are added depending upon the type desired, this in addition to the transfer available by heat treating.

The germanium is prepared by the reduction of Ge O_2, which is obtained from Ge Cl_4. Samples are usually prepared in 50 gram ingots. The Ge O_2 is then reduced in hydrogen at 650° C to form sponge germanium. The reduction is then carried one step further by increasing the temperature to 1000° C, the germanium is then 99.8% pure and is called a 'button'. Now to obtain the germanium crystal for transistors the 'button' is fused in an atmosphere of helium and placed in a cylindrical crucible and heated by an external induction coil. The coil is raised gradually, allowing the bottom to solidify first forcing the impurities upward. This type of cooling establishes constant composition layers.

The heat treating studies to determine resistivity and rectification characteristics of the 50 gm. ingots are carried out by cutting each ingot in half. For the resistivity measurements, a block $\frac{1}{8}'' \times \frac{1}{8}'' \times 1''$ is cut from half of the ingot. The other half of the ingot is used for the rectification measurements. The accompanying curves show sample characteristics for the different type of semi-conduction. The type is determined by the heat treatment received by the germanium and is completely reversible.

Since the method by which the ingot was cooled caused impurities to rise, it is reasonable to assume that the peak inverse voltage would be related to purity. The sketches show that the purer the specimen the lower the temperature at which it can be transformed to type j, and, as previously, stated the conversion is completely reversible.

The resistivity curves show the resistivity increases with the purity of the germanium and is a maximum at the n to p conversion point.

The conclusion could now be drawn that heat treatment changes the donor acceptor balance, and that conductivity depends upon which carrier is in excess.

Now, before the various types of transistors are taken up, it might be well to assume a convention regarding sign of the current and voltage. The arrows point in the forward direction.

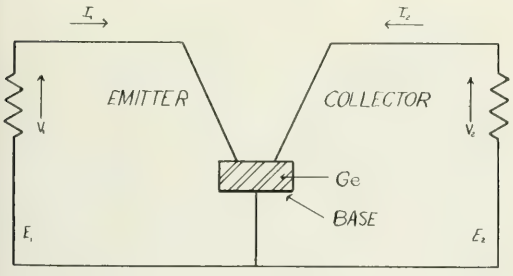


Figure 3.

The early transistors were unstable and for that reason were mostly of laboratory interest.

They will be discussed largely as background information leading to the newer most stable junction type. The first experiments on transistors were carried out on what is now called a type A transistor and its amplification was achieved by locating of 'cat whiskers'.

The following table lists some average values that were obtained from an early type A transistor.

	Voltage	Potential with Respect to Ge. Impedence
Emitter	.5 to 1	+ 300Ω
Collector	70	— 10K to 50KΩ
Amplification	2.5	
When R_1 = 20K & f = 5KC		
Gain	25 to 35 db with 10 db mismatch	
Power gain	15 to 25 db	

On these early type A transistors the available power was increased from 25 to 600 milli-watts. The maximum frequency seemed to be at about 4 mc for the n type and 50 mc for the p type. These values have of course been very greatly improved upon by later developments, a few of which are shown here.

The wedge type, double surfaced transistor, has unstable characteristics since it was very difficult to hold the whisker in a given location. This difficulty of maintaining physical location of the whiskers was overcome by the development of the coaxial transistor. This type uses a wafer shaped germanium crystal with concave surfaces.

The double surface transistors have the advantage of electrostatic shielding between input and output circuits, and avoid construction problems involving the placing of two spring contacts within a few thousands of an inch of one another.

Many other types of transistors were experimented with. For instance, in Britain's Telecommunication Laboratories, White has worked with multi-electrode point contractors, single surface types. Some of White's findings have shown that if two emitters are used with one biased more positive than the other, the current gain is increased by a factor of 2 or 3, and if two collectors at the same potential are used, a power gain of approximately $\sqrt{-2}$ will occur.

The most recent development has been the junction type transistor which uses the heat treated germanium. The n-p-n type has been developed with very stable characteristics which can be controlled in manufacture.

(1) Relatively low noise figure—between 10 & 20 db at 1000 cps

(2) Freedom from short circuit instability

(3) High gain—from 40 to 50 db per stage

(4) Power handling capacity—2 watts power dissipation 48 or 49% efficiency out of a possible 50% for class A operation.

(5) Ruggedness and small size—looks like plastic bead about 3/16" in diameter

(6) Free from microphonics

(7) Small power consumption—approximately .6 microwatts (as compared with a million or more microwatts required to heat ordinary cathode.)

(8) Limited frequency response—by using suitable mismatch a flat response to about 1 mc is available.

As an example of the circuit work that can be done with the transistors, a two stage grounded emitter emplifier which produces about 90 db power gain can be built in approximately a square inch of space.

In this paper it has been attempted to give a small amount of the elementary theory of transistors including how the crystals are obtained. A few of the many problems that existed in transistor work have been solved and it seems that with the effort that is being expended today it will only be a matter of a short time until the major disadvantages will be far enough behind us in order that the transistor can come into wide commercial use, where small power triodes are needed.

announcing the 1953 . . .

Engineering Open House

Dear Technograph reader,

We here at Illinois are proud and happy to claim our engineering school as one of the best in the country. The college of engineering, itself, however, is very modest about its achievements. At least, it is modest on 363 days of the year. On the other two days of the year the doors of the engineering college are thrown wide open to allow you, the general public, to see what marvelous things have been done in the technical fields here at the University of Illinois.

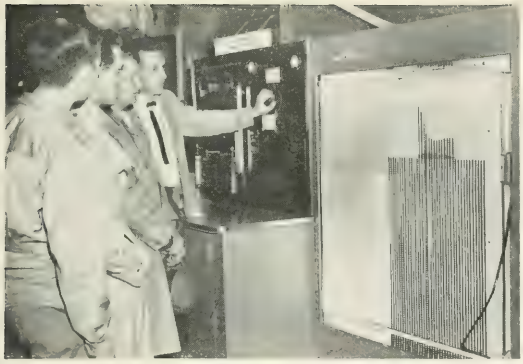
The engineering open house at Illinois for '53 will be held on Friday and Saturday, March 27 and 28. Two innovations concerning the open house are being tried this year. In the past the open house had been held every two years. Now, on a trial basis, the open house is being held every year. Also, the date for the show has been changed from the traditional St. Patrick's Day to a later date, in the hopes of having a little better weather.

Since you are a reader of the Technograph, you probably have a natural curiosity about engineering in any size, shape or color. The engineering open house will try to help satisfy this curiosity. Exhibits and demonstrations in all fields of engineering from chemical to civil, from metallurgical to mechanical will be shown. These exhibits will not be too technical in nature. They will be geared so that the layman can understand them. Special stress will be placed on the educational value of the exhibits to high schools, and tentative plans are underway to send invitations to every high school in the state.

Everything will be done to make your stay at Champaign-Urbana during the open house a pleasant one. Lunch stands will be in operation and a picnic area will be furnished for those who wish to bring their lunch. Housing will be obtained for those who desire it. Also tours of the whole Illini campus will be run as a sidelight.

In closing, let me again extend a hearty invitation to you all, from professional engineer to high school student, to attend the 1953 engineering open house.

Sincerely,
Bob Schrader,
General Chairman



The Aeronautical Engineers demonstrate the operation of the wind tunnel. An airfoil section is being tested to show pressures on the surface.

One beautiful test model plus 5,000 paper napkins yielded a trophy to the Institute of Aeronautical Sciences for one of the best floats in the Engineering Parade that preceded 1950 version of the Engineering Open House.

The Mechanical Engineers crusade power plant testing with their unique float.

introducing . . .

by Robert Hardin, E.E., '54, Robert Barrett, Gen. E., '56,
and H. W. Busey, E.E., '56

PROFESSOR A. O. HANSON

Few people realize that there is a man on this campus who had a part in creating the atomic bomb. He is Professor A. O. Hanson of the physics department.

Professor Hanson is at present working with research concerning the development of liquid hydrogen and deuterium targets for use with the 300 m.e.v. betatron. The study of the disintegration of deuterium by high energy X rays is his main interest at present. Much of his time is spent at the University betatron.

In the past four years Professor Hanson has worked on projects involving the study of neutron binding energies in the atomic nuclei. The 22 m.e.v. betatron was used for this research.

Another recent research project conducted by Professor Hanson concerned

PROFESSOR A. O. HANSON

the use of the external electron beam from the 22 m.e.v. betatron for the study of electron scattering and radiation and ionization losses of electrons.

A native of North Dakota, Professor Hanson was born on farm near Braddock. His family later moved to Grand Forks where he acquired his high school education and also his bachelor's degree in education from the University of North Dakota in 1936. For a year he taught high school science and math in Pine River, Minnesota, and then returned to North Dakota to receive his master's degree in 1937. In 1938 Professor Hanson started work at the University of Wisconsin as an assistant teacher. He obtained his doctor's degree in 1942 at Wisconsin where he worked with nuclear physics. In 1943 the project in which he had a part was moved to Los Alamos, New Mexico, so Professor Hanson moved with it and became a part of the great, secret, bomb experiment. He had a vital part in determining the critical mass and other details of the bomb.

On August 6, 1945, he witnessed the first bomb test at Los Alamos and was not surprised at all by its success. The scientists had worked so hard and made such a thorough study of the project that they were confident that the results would prove successful. At this time the experiment was unknown to the public.

He stayed at Los Alamos until late 1945, when he came to Illinois and continued his research interests with the betatron and also returned to part-time teaching.

Professor Hanson was married in 1942 after obtaining his doctor's degree. His wife's name is Elizabeth Marie and the couple have three children; Andy, 8 years, Don, age 6, and Ardith Marie, 3 years old. Professor Hanson appears not at all like the common conception of a college physics professor. He is young, tall, and good looking with a very modest opinion of himself and his accomplishments which include several minor patents on some of his new ideas in physics. This fine fellow is certainly a credit to the University of Illinois.

SHERWOOD PARKER

Vice Chairman of Freshman Council, Business Manager of Spring Carnival, Homecoming Stunt Show General Chairman—these are but a few of the many activities of Sherwood Parker, physics student extraordinary.

Sherwood hails from Chicago's North Side and Sullivan High School. He is a senior in the College of Liberal Arts and Sciences, with a physics major and a mathematics minor.

In addition to the activities listed above, Sherwood was Student Representative of Freshman Week and the Illini Union's Classical Music Hour Sub-Chairman during his freshman, sophomore, and junior years. Also during his sophomore year, he was Business Manager of Spring Carnival and General Chairman of Homecoming Stunt Show. During his junior year he was also General Chairman of Spring Carnival. And this, his senior year, he is Director of the Illini Union Department of UNESCO and International Affairs. "All of which," says Sherwood, "keeps me pretty busy, but I feel better if I don't get too much sleep, anyway."

His activities haven't cut too deeply into his study time, however, for Sher-

SHERWOOD PARKER

wood Parker has a 4.901 grade point average.

He is a member of Phi Eta Sigma, freshman men's scholastic honorary; Tomahawk, independent sophomore men's activity honorary; Sachem, junior men's activity honorary; Ma-Wan-Da, senior men's activity honorary; and Phi Kappa Phi, all-university scholastic honorary.

Sherwood's hobby is railroads. He subscribes to various railroad magazines, likes to take pictures of trains, collects time-tables, and is interested in everything that pertains to railroads. To foster this interest, he is a member of the Illini Railroad Club.

Graduate work in physics lies in the future for Sherwood, and when he has his Doctor's degree, his future lies in physics research.

So the *Technograph* salutes Sherwood Parker, who has so successfully combined a curriculum in physics with many and varied extra-curricular activities. Indeed, tribute is due him, and we wish

(Continued on page 42)

atomic research at . . .

BROOKHAVEN NATIONAL LABORATORIES

by Martin Goldstein, Chem. E., '55

Nestled among the chicken farms and potato fields about 75 miles from New York City lies the birthplace of tomorrow's atomic wonders, Brookhaven National Laboratories. This installation of the Atomic Energy Commission occupies the site of the former Camp Upton where one-sixth of all World War II recruits were inducted.

At Brookhaven our scientists are working on such things as cancer treatment, crop growth and food supply, and billion volt atomic bullets. Only one part of this establishment is restricted to the general public. This is the atomic pile which is in a super-modern, cube-like building built at a cost of $5 million.

The latest miracle of atomic physics is located at Brookhaven. It is the 2200-ton, $5 million cosmotron, shaped like a donut with a diameter of 65 feet. This is the machine which generates the extremely high voltage atomic bullets that travel at 175,000 miles a second, not too far, incidentally, from the speed of light. With this modern marvel Brookhaven's atomic physicists expect to create the fundamental bricks of the universe itself.

One of Brookhaven's main projects is the study of cancer. In a 36-bed

The atomic pile is cooled by blowers which suck 300,000 cubic feet of air per minute.

experimental hospital patients with certain types of cancer are cared for. In order that nothing may go unobserved, each patient has one doctor, one nurse, and one technician.

For the first time, experimenters are able to trace the growth of living cells. This is done on a large field where periodic crops of tobacco, corn, and barley are exposed to radiation. A greatly increased food supply is hoped to result from these experiments.

When Brookhaven first opened, the resident farmers of the area were hostile due to the belief that the radioactive rays would be allowed to invade their homes and fields and possibly sterilize their chickens and themselves. Since none of their fears have been realized, they have become indifferent to the project. However, because Brookhaven's 1400 scientists and supporting workers operate on an annual budget of $8 million (over $5 million of it in salaries), neighborhood merchants have developed a fondness for the place.

To guard against the harmful effects of the radioactive rays, Brookhaven is equipped with eleven-ton steel doors, first of all. The air used to cool the atomic pile is led off through a 320-

(Continued on page 42)

Front view of the new hot laboratory at Brookhaven National Laboratories, located at Upton, New York. The two story structure covers thirty-five thousand square feet of ground.

ELECTRONIC DIGITAL COMPUTER

by Hank Kalapaca, E.Ph., '53 and Ken Kolence, Physics, '53

A new student matriculated at the University of Illinois last September. This student, commonly referred to as a "brain," can work problems in five hours that would take a skilled mathematician all his working life. Of course, we are speaking of the new electronic digital computer which is now housed in the Engineering Research Laboratory here on the University campus.

One point which should be made clear in any discussion on computing machinery is that the term "brain" when applied to these devices is a misnomer. If there is any mental ability inherent in these devices, it is all derived from the people who design them and prepare problems for them. Indeed, the best description of the situation which faces the person who prepares a problem for a computer is to imagine that the computer is a moron who must be told every step of the computation and who blindly follows the instructions given it without any judgment as to their correctness. The only people who have any tendency to give a computer any sort of personality are the engineers who are given the task of keeping the machine in good working order. To such people, the computer sometimes seems to be a malevolent being which takes a fiendish delight in developing faults which are exceedingly difficult to track down.

University Computers

The Digital Computer Laboratory of the University early in 1949 began construction of two quite similar machines. The first of these is called ORDVAC — Ordnance Discrete Variable Automatic Computer and was installed at Aberdeen Proving Ground, Maryland in February of this year. The second computer was completed about two months ago and is now being used as a research tool at the University. The University machine is unique among large scale computers now operating in this country in several ways. It is the only machine which was completely financed by a university and whose time is completely available for university research purposes. The University machine is also unique in that it as yet has no trick name—such as ORDVAC, ACE, ORACLE, MANIAC, or OMIBAC.

Organization

One of the better ways of describing the general organization of a large scale automatic digital computer is to compare the computer with an ordinary desk calculator which all of us have used at one time or another. Indeed, the necessity which led to construction of large scale automatic computers was simply the need to speed up and automatize the sort of calculation which is done on a desk calculator.

Suppose we take as our example the calculation of the sum of the squares of a pair of numbers x and y. Let us examine in detail how we would do this using a desk calculator. We have the following items:

1) A data sheet listing values of x and y, upon which we record corresponding values x^2+y^2
2) A work sheet for recording intermediate results which are x, y, x^2, y^2
3) A desk calculator
4) An operator

The steps we would go through are summarized in figure 1.

There are several analogies between the items of the calculating procedure and an automatic digital computer. The desk calculator itself corresponds to what we call the arithmetic unit of the digital computer—the arithmetic unit is capable of executing the operations of arithmetic at high speed addition, subtraction, multiplication, and division. The work sheet used for remembering intermediate results is analogous to what is called the memory of the digital computer. The operator of the desk calculator corresponds to the control of an automatic digital computer. Finally the automatic computer has an input-output mechanism which performs functions analogous to transferring data to and from the data sheet.

The first point which should be made here is that the automatic com-

STEPS in CALCULATION of SUM of SQUARES

Work Sheet	Desk Calculator	Automatic Computer	
x	Read x from data sheet	T	
3	Write x on work sheet	W	1
y	Read y from data sheet	T	
4	Write y on work sheet	W	2
x^2	Punch x on calculator	R	1
	Multiply by x in calculator	X	1
9	Write x^2 on work sheet	W	3
y^2	Punch y on calculator	R	2
	Multiply by y in calculator	X	2
16	Write y^2 on work sheet	W	4
$x^2 + y^2$	Punch x^2 on calculator	R	3
	Add y^2 in calculator	+	4
25	Write x^2+y^2 on work sheet	W	5
	Record x^2+y^2 on data sheet	P	

T	Transfer number from data tape to arithmetic unit.
W (n)	Write number in arithmetic unit into address of memory
R (n)	Read number at address n of memory & transfer it to arithmetic unit.
X (n)	Multiply number in arithmetic unit by number at address n of memory, leaving the result in the arithmetic unit.
+ (n)	Add number at address n of memory to number in arithmetic unit, leaving the result in the arithmetic unit.
P	Print the number in the arithmetic unit.

Figure 1

puter is capable of handling all steps of the calculation just described, automatically — not only the arithmetic operations of addition, multiplication, etc., are executed automatically at high speed, but also the various data transfers between memory and arithmetic unit, and between arithmetic unit and input-output media are completely automatic.

The second point is that a general purpose digital computer must be sufficiently flexible to handle any desired sequence of operations necessary for a numerical calculation. This is accomplished by coding instructions in numerical form and storing them in sequence in the memory. The computer control then automatically consults successive locations of the memory, decodes the numerically coded instructions, and executes them.

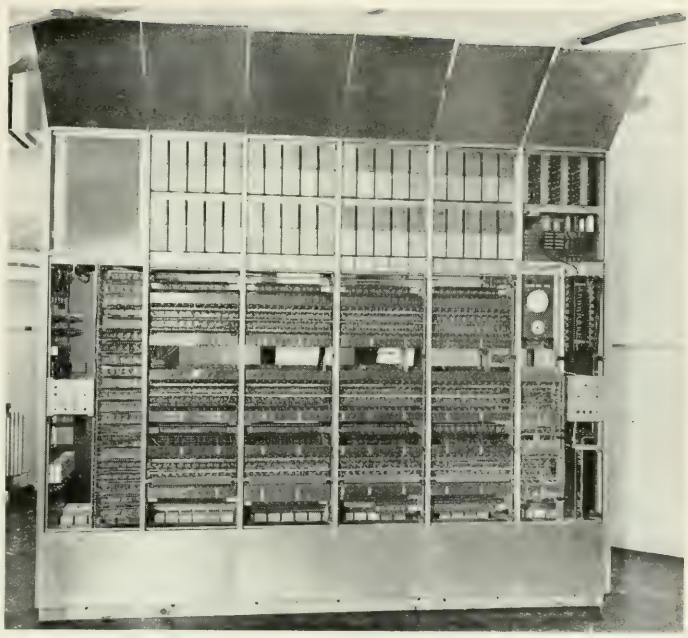
Additional instructions for arithmetic operations such as subtract, divide are included in most machines. Also included in the list of instructions of every automatic computer is what is called a control transfer instruction. It is the function of the control transfer instruction to alter the sequencing. There is also what is called a conditional control transfer instruction which permits the computer to alter the sequence of instructions executed on the basis of computed results.

The sum of squares calculation described is an exceedingly trivial one for an automatic computer. Next on the scale of complexity are what are known as subroutines—namely, sequences of instructions which are common to many different problem solutions. Examples of subroutines are those for computing square roots, trigonometric functions, logarithms, exponentials, and so forth. The sine of any angle, for example, can be computed from its series expansion in about a hundredth of a second by the Illinois computer.

Fundamental Concepts

One concept that is fundamental to the understanding of the operation of a digital computer is that any problem that is given to the computer must be resolved to the basic operations of arithmetic, namely, addition, multiplication, subtraction, division and the two types of transfer orders discussed above. Theoretically, all problems for which there is a known solution can be programmed and solved with the computer. Practically, however, it must be emphasized that because of the limitations of time, capacity of the memory and the complexity of programming, the solutions of many problems with a computer would be uneconomical.

The error which is inherent in the final solution is due to two factors. First, a typical problem solved on the machine involves an approximate method of solution. For example, in the calculation of the sine of an angle, only the first few terms of the equivalent series expansion are utilized. The second source of error is incurred in the roundoff of products and quotients. In complex problems involving numerous multiplications and divisions, the roundoff errors can build up to an appreciable amount.



A front view of the Illinois machine without its covers. (All photographs and diagrams courtesy of the Digital Computer Laboratory)

The binary number system is used in the Illinois machine. Actually, there are several good reasons for this choice. First of all, all machines have a logical and arithmetical part. The nature of mathematical logic is its binary character. Consequently, there is some reason for feeling that the binary system has an advantage from this point of view. Another reason for using the binary system can be found when one considers the efficiency of the various number bases. It can be shown mathematically that the most efficient number base that can be used is e (the base of natural logarithms). If one were to plot the efficiency versus the various number bases, he would see that the base two has an efficiency very close to the maximum. A third reason for choosing the base two (binary) system is found when one considers the arithmetic part of the computer. In order to obtain the fastest possible operating speeds, most modern digital computers are electronic in nature. Vacuum tubes, however, often have large variations in their voltage-current characteristics even though they are of the same type. Also, these characteristics have been found to change as the tube ages. Consequently, if one is going to use a vacuum tube as a digit representing device, the most reliable way to use it would be to have it vary only between two discrete states, cut-off and conducting. Operating in this way, we see that the tube is a binary device.

Flip-Flop

The basic circuit element within the machine is known as a flip-flop. It is capable of representing either binary digit, that is, either zero or one. The flip-flop itself, as used in the Illinois machine, is a twin-triode vacuum tube wired in such a way that when one triode is conducting, the other is cut-off. In the Illinois machine, it has been arbitrarily decided that the flip-flop will represent the binary number one when the right-hand triode is cut-off and the left-hand triode is conducting. Changing the state of the flip-flop is usually called gating or clearing, the term used depending upon how the change is carried out.

Detailed Analysis

The following discussion is a detailed analysis of the five main parts of the

(Continued on page 20)

COMPUTER . . .

Continued from page 19

computer. The majority of this discussion was derived from a technical paper which was written by Professors R. L. Meagher and J. P. Nash, both with the University of Illinois.

Arithmetic Unit

The arithmetic unit is made up of three parts: the registers, the adder, and the digit resolver. The registers are four in number, the accumulator, the arithmetic register, the number register, and the order register. Of the registers named above, the latter two are nonshifting registers each of which consists of 40 binary digits held in 40 flip-flops. Information is communicated through them to the arithmetic unit and control from the memory. The number register holds addend, multiplicand, and divisor for arithmetic operations. The order register receives from the memory all orders to be handled by the control.

The shifting registers (accumulator and arithmetic register) each consist of two rows of 40 flip-flops, one row above the other. Since a nonshifting register contains one row of 40 flip-flops, two nonshifting registers can be made out of one shifting register, and the appearance of the Illinois machine is that of a machine with three double registers.

In addition to the two rows of flip-flops, a shifting register also has two rows of gate tubes. These gate tubes furnish four gates for each stage of the register — two "up" gates and two "down" gates. The "up" gates transfer straight up, while the "down" gates transfer down one place to the left or one place to the right. The bottom row of a shifting register holds the digits while they are being sensed during an operation; the top row is used as transient storage. A shift is accomplished by clearing the upper row, gating up to it from the lower row, clearing the lower row, and finally gating down either one place to the left or one place to the right. When shifts are made in this way information is not cleared from one location until it has been deposited in another.

Figure 3 illustrates part of a register, the down gates into a lower flip-flop being shown. The plate supplies of a flip-flop come from busses which are normally at +150 volts but which can be lowered for the purpose of clearing the flip-flop to either state. Thus if the supply to pin 1 is dropped, the flip-flop is put into the 1 state. The 1 state is arbitrarily defined as the state when pin 2 is high and is distinguished by a neon on pin 2.

The plate of a gate tube goes to the plate of the flip-flop to which information is being transferred; the gate grid is attached to the grid of the flip-flop from which information comes. When the gate cathode is lowered, the gate tube conducts if the grid is high and changes the second flip-flop if it is connected to the high plate.

This means that the second flip-flop must be in the proper state for receiving the gated information. Suppose a down right gate is wanted. First, F_3 is cleared to the 0 state by lowering pin 2, thus making pin 1 high. Then the

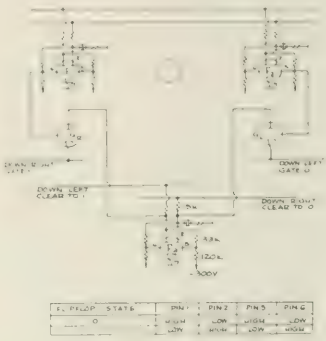


Fig. 3

cathode of G_r is lowered. If F_1=0, pin 6 is low, G_r does not conduct, and F_3 remains in the 0 state. It is thus the same as F_1. On the other hand, if F_1=1, pin 6 is high and G_r conducts. This causes pin 1 of F_3 to fall and turns F_3 to the 1 state. Therefore F_3 is the same as F_1.

The gating up in the registers is similar to the gating down except that only one "up" gate is ever used. This results in an extra set of gates which are not needed for shifting operations and are thus available for other use.

Access to the memory is in parallel from the accumulator and information from the input is supplied serially to the accumulator, utilizing the shifting properties of the register to put it in.

Similarly, the output is made serially from the arithmetic register, it being possible for the memory to communicate with this register.

The adder is a Kirchoff adder. The addend and augend digits control gates from two constant current sources which can allow current to flow through a summing resistor. The carry from the preceding stage controls the input voltage to the summing resistor. There are four possible voltages across the summing resistor, depending upon whether the sum at that particular stage is 0, 1, 2, or 3. If it is either of the latter two, a carry is produced for the next stage.

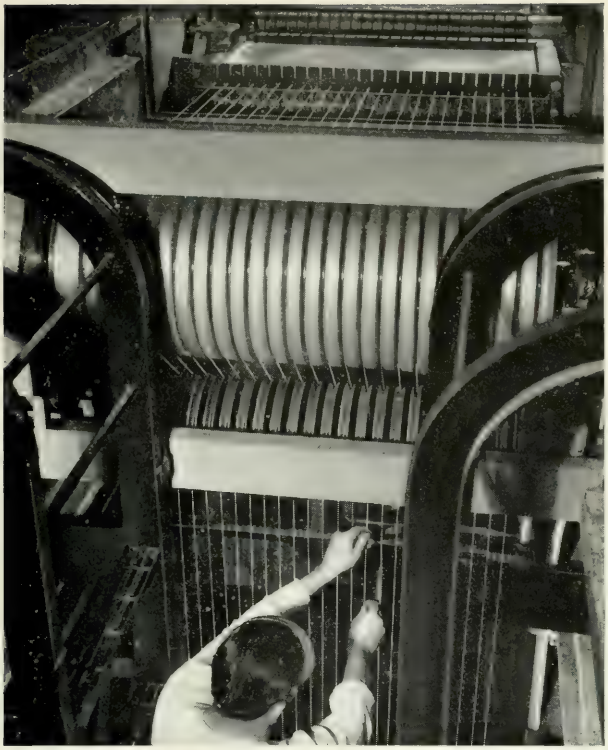
The summing resistor is a 10,300-ohm resistor and the constant current sources are cathode followers supplying 4.85 milliamperes. The carry causes the

(Continued on page 50)

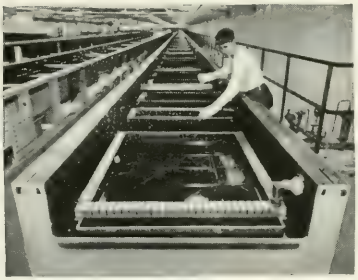
TABLE OF CHARACTERISTICS

MACHINE TYPE	PARALLEL, ASYNCHRONOUS
REGISTER CAPACITY	40 BINARY DIGITS
MEMORY CAPACITY	1024
MEMORY TYPE	ELECTROSTATIC
ADDER CARRY TIME	12 MICROSECONDS
ALLOWED CARRY TIME	16.5 "
ADDITION TIME	88.4 "
MULTIPLICATION TIME	
ALL 1'S, POSITIVE MULTIPLIER	1150 "
ALL 0'S, POSITIVE MULTIPLIER	670 "
DIVISION TIME	1150 "
MEMORY PERIOD	22.1 "
TIME TO LOAD ENTIRE MEMORY	46 SECONDS
TIME TO PUNCH CONTENTS OF ENTIRE MEMORY	7.3 MINUTES
TIME TO PRINT CONTENTS OF ENTIRE MEMORY	33 MINUTES
NUMBER OF TUBES	2867
MACHINE D.C. POWER	8.6 KW
MACHINE A.C. POWER	9.7 KW
TOTAL PRIMARY POWER (INCLUDING POWER SUPPLIES & BLOWERS	30 KW
KIND OF INPUT	5 HOLE TELETYPE TAPE
INPUT SYSTEM (SPACE IS 5 HOLES)	SEXADECIMAL
OUTPUT SYSTEM	SEXADECIMAL TELETYPE
NUMBER OF DIGITS ASSIGNED TO AN ORDER	8
NUMBER OF DIGITS ASSIGNED TO MEMORY ADDRESS	10
NUMBER OF ORDERS AVAILABLE	GREATER THAN 50

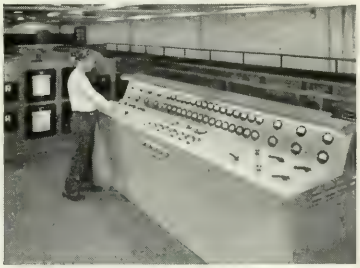
Figure 2



25 strands of steel wire start on their way to be electrolytically coated with copper, lead and brass.



Part of the 600 foot long electroforming machines where wires go through successive baths of plating solutions.



Console of controls for entire process is readily operated when necessary, even though seldom used in the almost fully automatic operation.

ENGINEERING . . . with a pioneering twist

There's a real incentive in working out ways to do things that have never been done before. And problems in pioneering are constantly cropping up at Western Electric—manufacturing unit of the Bell Telephone System.

For example: the revolutionary electroforming process dreamed up and made a reality by Western Electric engineers for making copper coated steel wire.

The big idea was this: Could a process be developed in which successive coats of copper, lead and brass would be deposited on steel wire electrolytically in one continuous operation?

Engineers of varied skills—electrical, mechanical, chemical, metallurgical, civil—went to work as a team. After solving many problems, they came up with a process that makes better, stronger wire at lower cost—does it at the rate of $1\frac{3}{4}$ billion feet per year.

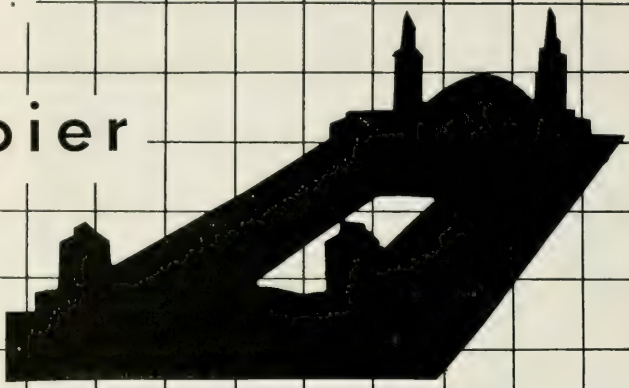
Recent developments such as microwave radio relay networks for telephone calls and television programs—operator and customer dialing of long distance calls—secret electronic equipment for the Armed Forces—promise an ever-widening field for young engineers of varied training at Western Electric.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

— *the university of illinois at . . .*

navy pier



by Edward Harris, Comm., '55, Norman Heldt, and Richard Steffen

THE WESTERN ELECTRIC STORY

What vital manufacturing processes lie hidden behind the guarded walls of Western Electric's Hawthorne Plant?

Gate One swung open to students of three universities, sponsored by the American Institute of Electrical Engineers, Chicago Section, to witness the assembly of telephonic equipment.

For over three-and-one-half hours futre engineers of the University of Illinois (Navy Pier), Northwestern and Illinois Institute of Technology witnessed the mammoth facilities of this large scale plant.

Time permitted inspection of only the Rod and Wire Mills, the Cable Works, the "Cross-Bar" works, and the Rubber and Plastic works.

Months of careful observation would be required to really know and understand the operations of Hawthorn's teaming city. Skilled specialists guided us through the maze of buildings and explained their functions.

"Copper Billets" are transformed into red-hot ribbons of shining wire by especially designed machinery in the rod and wire mills. The wire is pickled, ennealed, and cold drawn into various sizes. Aluminum is also being tested as a conduit, but it requires additional compensatory measures to serve as a conductor.

Tinted paper pulp is now applied directly to the wire for insulation. The older method wrapped the wire spirally with multi-colored rolls of paper. A specially designed machine twists the wire into final form, and heat-vacuum treatment is given to reduce the moisture content and provides better insulation.

Complex "Stranders" weave the individual wires together to form a cable.

Building at Western Electric Works located in Cicero, Illinois.

The "Strander," developed by engineers of Western Electric and Bell Laboratories, is unique in design and operation. As a protection against the elements of weather, corrosion, and rough handling, a "Sheath" of "Alpeth" (a covering made of aluminum and polyethylene) or "Lepeth" (lead and polyethlene) is applied to the cable.

Separate from the manufacture of cable is the manufacture of what is known as "Cross-bar" equipment. The Hawthorne plant produces almost all the necessary parts for the operation of a central office. The backbone of "Cross-bar" is built upon a series of relays and switches which speed up the process of completing calls, requiring less maintenance than the manual, Panel, or Step-by-Step Systems (the last three refer to dial systems).

Since almost all parts of the system are pre-assembled, fewer highly-skilled specialists are required at the location of installation.

Two fictitious telephone numbers may be used to illustrate the operation of the "Cross-bar" system: assume that a person at Dickens 2-1234 wishes to dial Edgewater 4-5678. The Dickens subscriber picks up his receiver to hear the "dial-tone" from a apparatus known as a "Sender." This "Sender" is only a small device composed of switches and relays, much like the larger "link frames," but it plays an important role.

After dialing the first three digits or "Office Code" (ED-4) the "Sender" calls into operation a device known as a "Marker frame." The "Marker" notifies the Dickens ex-

(Continued on page 52)

"I needed to 'Find' Myself— that's why I picked Allis-Chalmers,"

says A. J. MESTIER

Massachusetts Institute of Technology Sc. B.—1943
and now Manager, Syracuse District Office

"I WAS LOOKING for an engineering job, but I wasn't very sure just what phase of this broad field would interest me most. I didn't know whether I wanted straight engineering, sales engineering, production or some other branch of industrial engineering.

"Allis-Chalmers Graduate Training Course gave me a means of working at various jobs—seeing what I liked best—and at the same time obtaining a tremendous amount of information about many industries in a very short time."

Experience Typical

"My experience is typical in many ways. I started the Graduate Training Course in 1946, after three years in the Army. My first request was to go to the *Texrope* V-belt drive department. From there I went to the Blower and Compressor department; then the Steam Turbine department. By the time the course was completed in 1948, my mind was made up and I knew I wanted sales work. I was then assigned to the New York District Office and in 1950 was made manager of the Syracuse District. The important thing to note is that all Allis-Chalmers GTC's follow this same program of picking the departments in which they want to work.

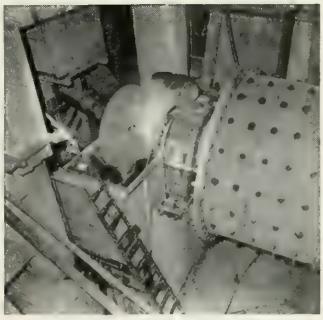
"Best of all, students have a wide choice, for A-C builds machines for every basic industry, such as: steam and hydraulic turbine generators, transformers, pumps, motors and other equipment for electric power; rotary kilns, crushers, grinders, coolers, screens and other machinery for mining, ore processing, cement and rock processing. Then there is flour milling machinery, electronic equipment and many others."

Taking surge voltage distribution tests on power transformer in A-C shops with miniature surge generator and cathode-ray oscilloscope.

A Growing Company

"In addition, new developments and the continuing growth of the company offer almost endless opportunities for young engineers.

"From my experience on the Graduate Training Course, I believe it is one of the best conducted in the industry and permits a young engineer to become familiar with a tremendous variety of equipment—both electrical and mechanical—which will serve him in good stead in his future profession."



Ball Mill grinds ore for large copper producer. Same type of equipment from Allis-Chalmers pulverizes much of nation's cement.

Texrope is an Allis-Chalmers trademark.

ALLIS-CHALMERS

For information call the Allis-Chalmers District Office in your locality or write to Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin

skimming industrial headlines

ediated by Charles LaRobadier, M.E., '55, Maurice Garnholz, A. E., '56,
and Martin Goldstein, Chem. E., '55

New Sound Laboratory

A "point of no return" for echoes has been built into a new sound laboratory by Westinghouse Electric Corporation. More precisely called an anechoic chamber, the room will enable research engineers to study noise—its source, cause, and measurement.

Dr. Patrick Conley, manager of acoustical research at Westinghouse Research Laboratories, stated, "elimination or reduction of noise in the present lines of Westinghouse equipment is valued at close to half a million dollars every year for each decibel of sound diminution."

The laboratory is located in a suburban area of Pittsburgh, Pennsylvania, where the surrounding noise level is quite low. Inside the main building and surrounded by masonry walls 12 inches thick, a 19 by 13 by 10 foot room has had its walls, roof, and floor completely covered with insulating material shaped in the form of wedges. These wedges are the very heart of the anechoic chamber, for it is their shape, composition, size, and number that determines the efficiency of the room. Fabricated from glass wool, each wedge is 8 by 24 inches at its base and 34 inches long. Wire mesh with ½-inch openings encases each wedge to facilitate installation and protect the easily damaged filler.

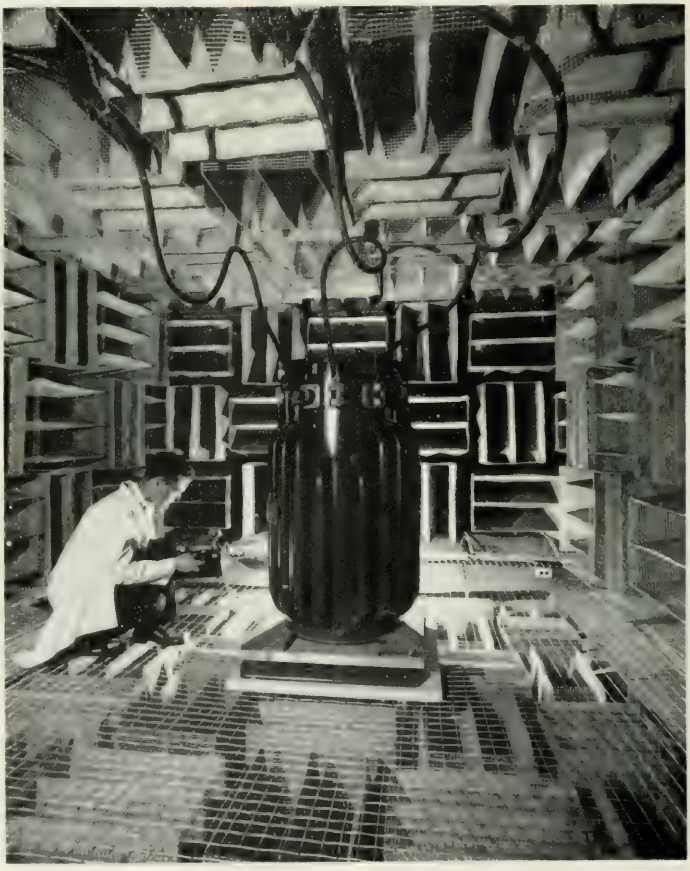
A spring supported wire net is stretched from all four side walls several feet above the wedges which cover the floor of the chamber. This working platform will support equipment to be tested. Overhead, necessary types of service lines are available to operate the various test pieces. Since only the noise source plus a microphone pickup will be inside the room during test runs, all gauges and recording devices are located on control panels in an adjoining room.

In a so-called "free sound field," such as would exist at an altitude of 50 or 100 miles, sound waves would emanate from a source in all directions and their intensity would decrease as the inverse square of the distance from the source. This would, of course, preclude the presence of any kind or magnitude of background noise. Since there would be no surrounding walls or obstacles in this "free field," no reflections of sound would occur—hence no echoes. These are the physical factors that Westinghouse engineers have endeavored to build into their anechoic chamber.

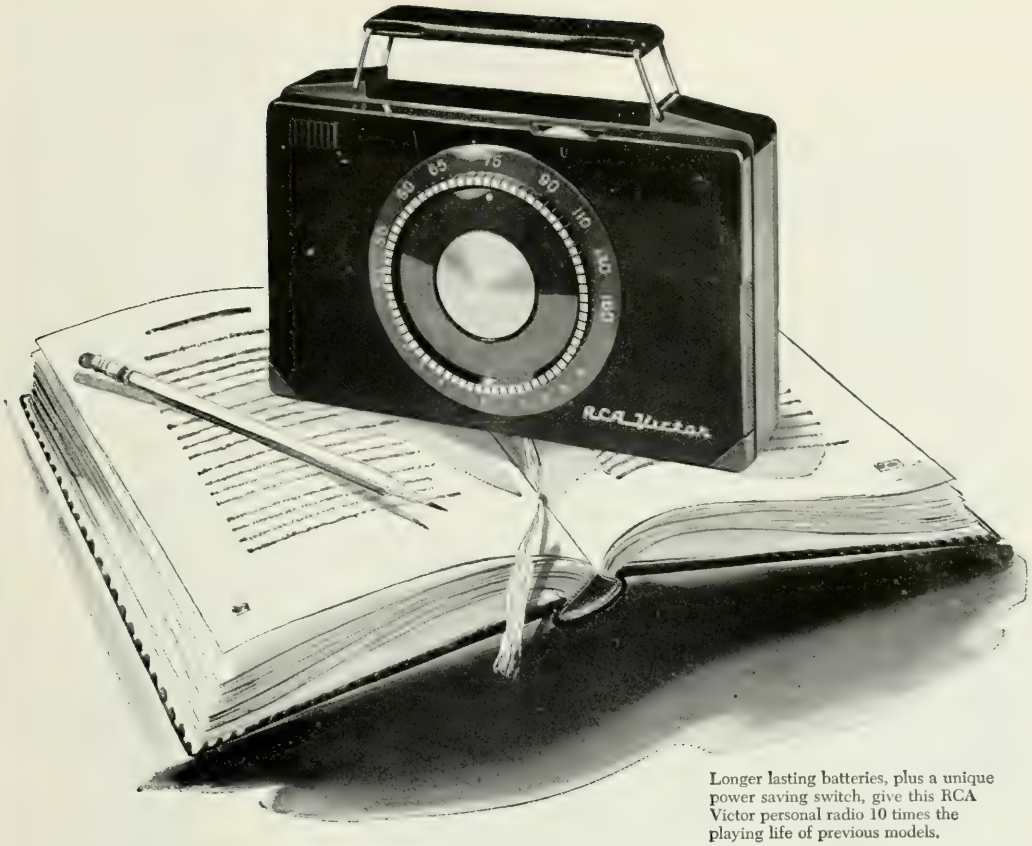
The quiet site location of the lab and the type of wall construction have produced a very depressed encompassing sound level. The design of the wedges themselves absorbs and prevents reflection of sound waves. According to Dr. Conley, a sound level within the room of 10 to 15 decibels is anticipated. In comparison, a residential neighborhood at night has a noise level of 25 to 30 decibels.

One of the problems that will be studied in the new sound laboratory will be that of determining a standard method of measuring noise. Although certain limits of sound emanation for each type of electrical equipment are specified by the National Electrical Manufacturers Association, the method of measuring noise throughout industry varies widely. This has led to confusion and in some cases rather large unnec-

(Continued on page 26)



Sound level of industrial transformer is determined.



Longer lasting batteries, plus a unique power saving switch, give this RCA Victor personal radio 10 times the playing life of previous models.

New Personal Radio...plays 10 times longer

About the size of the average book, this new Personal radio—developed through RCA research and engineering—offers new convenience and economy to those who want a light, beautifully streamlined, long-lasting instrument.

Secret of its long life is a new dry cell "B" battery—used in combination with redesigned "A" batteries to create a more lasting power source. Additional life is given by a unique switch, for use in areas where radio reception is strong, which reduces the drain on the batteries, and adds up to 30% to their lives. RCA Victor's new receiver plays *instantly*, without needing to warm up, has an automatic control to keep the sound volume even, and can be had in six rich colors.

Development of this compact radio is another example of RCA research and engineering at work for *you*. RCA research means better quality and performance from any product or service of RCA or RCA Victor.

* * *

See the latest in radio, television, and electronics at RCA Exhibition Hall, 36 West 49th Street, N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y.

CONTINUE YOUR EDUCATION WITH PAY—AT RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey. **Also many opportunities for Mechanical and Chemical Engineers and Physicists.**

RCA® *RADIO CORPORATION OF AMERICA*

World leader in radio—first in television

SKIMMING . . .

Continued from page 24

essary expenditures.

Other investigations will lead to sound reduction in many types of equipment including ballasts in flourescent lighting fixtures, transformers, refrigerators, vacuum cleaners, air conditioning units, speakers for home radios, and jet engine test cells.

Dr. Conley emphasized that the sound study program will not be a rapid one with solutions to present noise problems as their immediate goal.

"We must first," he said, "understand thoroughly the detailed causes of the various sounds, their means of propagation and radiation, and their psychoacoustic effects—the effects on the human ear of sound level and frequency. With these problems solved, various apparatus noises can be reduced or eliminated more easily.

Better Focusing for Color TV

A new cathode ray picture tube which will help give high-accuracy focusing to color television in the nation's motion picture screens has been developed by GE recently.

The new five-inch tube will be used on television cameras being produced by GE for 20th Century Fox, which is developing the so-called "Eidopher" system for theater projection of color television.

The new tube will be used in the camera's electronic view finder with which the cameraman focuses on his subject.

The tube is characterized by extreme brightness and high definition qualities which will enable the Eidophor cameraman to bring his subject under the most accurate focus possible.

GE engineers pointed out that a highly-accurate focus is a "must" in a system of television projection onto a large screen because the slightest focusing inaccuracy would be magnified many times on the screen.

Key to the brightness and definition qualities of the new tube, type number GL-5QP4, is an aluminized screen which not only increases brightness, but also improves picture definition and resolution.

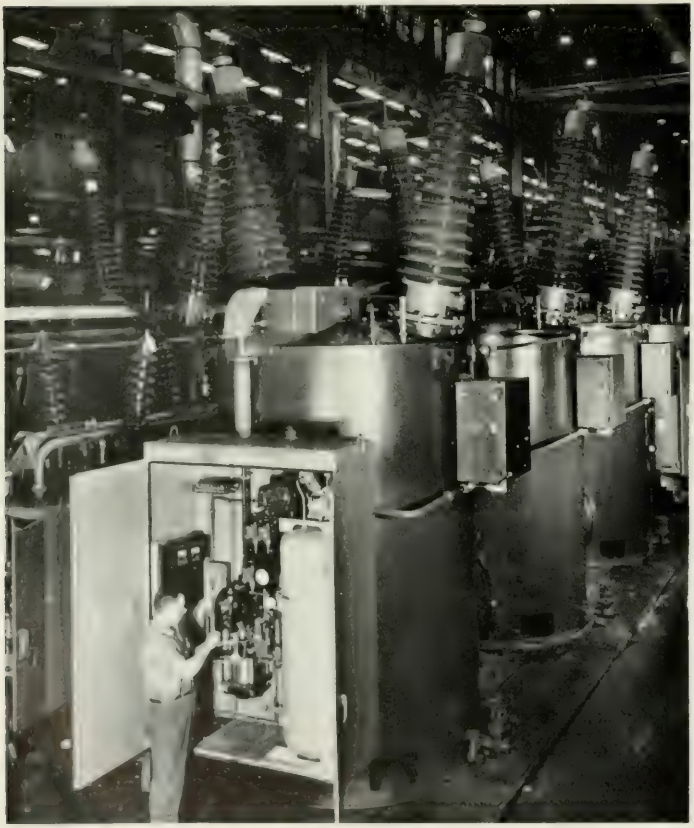
In addition to its use in Eidophor cameras, the tube will also be used in all GE television studio cameras.

Its small size will also make it ideal for portable units and its brightness qualities will make it useful under bright sunlight conditions which cause pictures on normal tubes to "wash out."

Use of the aluminized screen is also expected to lead to the long life for the tube because of the reduction in ion burns and general screen deterioration.

In defending his state, the Arizona native was saying, "All we need is a better type of settler and more water."

"When you come to think of it," retorted the tourist, "That's all that Hell needs."



Workman adjusting one of the oil circuit breakers built with the new pneumatic operating mechanism. (All cuts courtesy Westinghouse)

Pump With No Moving Parts

The only resemblance between conventional pumps and one recently developed by General Electric is the name. Unlike usual pumps, which either push or suck liquids from one place to another, this new pump uses invisible magnetic forces to push molten metals around.

Having no moving parts, the pump applies basic electromagnetic principles to move molten metal (temperatures up to 1000 degrees F.) at relatively high speed (up to 28 gallons per minute). The molten metal is pumped by application of a magnetic field by an electromagnet, at the same time a high electric current is passed through the metal. The problem of maintenance is greatly reduced by the absence of moving parts in this pump.

Keeping Good Spirits Good

Since good spirits must be kept in that condition, the old oaken casks and other traditional storage vessels for liquors are yielding to more modern materials—materials that are easy to clean and keep clean, and which will protect the color, flavor, and other qualities of high-proof beverages. Metallic storage and blending tanks, fabricated from Inconel, a product of the International Nickel Company, Inc., have been first used instead of glass-lined or oak tanks as liquor containers by the Quebec Liquor Commission.

Long and thorough tests of the possibilities of keeping spirits in contact

(Continued on page 56)

Maybe *You* belong in one of these Square D pictures...

● Design engineers—production engineers—application engineers—field engineers—it takes their combined teamwork to create, build and distribute Square D's broad range of electrical distribution and control equipment.* The vast majority of our men come from schools such as yours. We're proud of them—they're equipped and ready to grow. They're the kind of men you will like to work with.

**Mechanical, electrical, general and industrial engineers are needed*

***Mail the Coupon** for a 16-page "get-acquainted" brochure*

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by T. E. Beling, E.E., and Oliver Smith, M.E., '54

In recent years, much has been said and written concerning the value of cultural studies to technical students in colleges and universities. Educators have decried the fact that engineering and scientific students frequently are enrolled in curricula of such an entirely technical nature as to exclude subjects of importance to the truly educated man. The fine arts, government, economics—these are often neglected entirely or passed over in the most cursory manner. Engineering educators have in most cases realized that the case for liberalization of the engineering curriculum contains many valid points, and great efforts have been made to change and broaden the curriculum along these lines.

There is, however, another face to the coin. No one denies the value of at least some cultural study for engineers, but very little attention is paid to the idea that there may be a good deal of benefit in some engineering studies for those enrolled in the so-called liberal curricula. Frequently, both students and faculty in such fields as the arts, education, history, and so forth, regard the engineer with more or less good-natured contempt because of the engineer's lack of learning in other than technical matters. These same people are generally horrified if questioned as to their knowledge of even the most elementary concepts of engineering. Often, they regard ignorance of basic mathematics, simple mathematics, the fundamentals of electricity, and allied subjects, as only natural for an educated person. So-called "liberal" people have a tendency to dismiss their lack of understanding of even the simplest technical matters with an airy indifference and a large amount of self tolerance.

Nevertheless, there is a great deal to be said for the idea of introducing all students at colleges and universities to a few of the rudiments of the engineering profession. We live in a technological society which is daily becoming more complex, with the introduction of new and improved devices to make living easier and more interesting. No one can deny the truth of this statement, but many people choose to ignore this phenomenom, mainly because they are afraid that it is too difficult for them to understand anything about the machines and devices which are being turned out in ever-increasing number. Of course, it would be impossible to give everyone a detailed understanding of the operation of all the devices in common use today, but it should not be too difficult to impart at least a little basic knowledge of some engineering principles to all college students.

It would be an utter impossibility (and a waste of time) to require all students to thoroughly understand the operation of a television set, but certain basic principles of electricity would undoubtedly prove to be of great value to everyone. For instance, many times servicemen are called to homes because of the supposed non-operation of a radio or television set only to find that the set was disconnected or that it was connected to a dead circuit. Ridiculous? Yes, but it happens. It would not be necessary to explain the principles of electron flow in conductors in order to teach future housewives to test a circuit by plugging in a lamp which is known to light in another part of the house. Almost all adults sooner or later learn to drive a car, and many people drive daily, but very few people have even the vaguest understanding of what makes the wheels turn. Even the finest mechanisms are not perfect, and often cars are not accomodating enough to break down outside of a fully equipped repair shop. Take even so common an occurence as running out of gas. Almost everyone sooner or later has to walk a few miles to a gas station for a gallon or two of gas. However, suppose that the charge in the battery is low—how many people know that the easiest and best way to start the car is to pour a small quantity of the gas in the carburetor? For that matter, how many people know where the carburetor is and what it does to justify it's existence? Elementary? Yes, but the woman who pulled out the choke handle and hung her purse on it was a college graduate.

Many more examples of this type are familiar to everyone, but it seems obvious that there is definitely a place in the education of every college student for a little elementary engineering, just as much as the engineer should have at least a nodding acquaintance with the more liberal fields.

News from the Miserables Branch

The U. of I. Branch at Miserables, Illinois, celebrated its annual homecoming on October 25. The fraternity tent was nicely decorated and the sorority residence held an open house. The homecoming game between the "Branch" and Arras College was played in Alumni Memorial Pasture before a throng of 300 people. The Athletic Department set up several chairs but so many people had to stand that there is sure to be considerable future agitation for a stadium or at least bleachers. In the pre-game ceremonies, President Madeleine welcomed all of the guests; Chaplain Myriel read the invocation, and Campus Security Officer Javert threatened the crowd with dire punishment if any misconduct was discovered. Then Cheerleader

(Continued on page 30)

THE HYDROSTATIC TEST

Nobody can buy a length of cast iron pipe unless it has passed the Hydrostatic Test at the foundry. Every full length of cast iron pipe is subjected to this test under water pressures considerably higher than rated working pressures. It must pass the test or go to the scrap pile.

The Hydrostatic Test is the final one of a series of routine tests made by pipe manufacturers to assure that the quality of the pipe meets or exceeds the requirements of standard specifications for cast iron pressure pipe.

Few engineers realize the extent of the inspections, analyses and tests involved in the quality-control of cast iron pipe. Production controls start almost literally from the ground up with the inspection, analysis and checking of raw materials—continue with constant control of cupola operation and analysis of the melt—and end with inspections and a series of acceptance and routine tests of the finished product.

Members of the Cast Iron Pipe Research Association have established and attained scientific standards resulting in a superior product. These standards, as well as the physical and metallurgical controls by which they are maintained, provide assurance that cast iron pipe installed today will live up to or exceed service records such as that of the 130-year-old pipe shown.

Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction. Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3, Illinois.

Section of 130-year-old cast iron water main still in service in Philadelphia, Pa.

CAST IRON PIPE SERVES FOR CENTURIES

BONEYARD . . .

(Continued from page 28)

Cosette called for the cheer "Yea Parents" three times and "Fight, Fight, Fight." No one cooperated, but a couple of fellows were getting pretty gay and probably were taken care of when they got home.

The team won a moral victory, holding Arras to a 27 to nothing victory. The "Branch" almost scored on one play when fullback Marius broke into the secondary. The Arras team thought a time-out had been called. However, his jersey fit like a nightgown and it was easy to catch him from behind. The entire team covered themselves with glory that day and especially the ones who dove on what they thought was the football.

The campus is all aflutter because Dean W. L. Everitt of the "home office" will come to Miserables next week to address the student body. A full report on his visit will be sent to the *Technograph* next month.

PROFESSIONAL SOCIETIES?

As a student goes through an engineering college his first two years are spent dealing with general material with little emphasis on his chosen phase. This is necessary so that he will receive a thorough basic education before delving into the deeper and more fascinating aspects of his preferential curriculum. This does not mean, however, that he cannot begin to orient himself with his future occupation .

In practically all phases of engineering, professional societies have been instituted for the betterment of the profession. Starting with the ASCE in 1852, each branch of engineering has founded an organization of its professed participants. The first aims of these societies were to establish standards for use in industry and schools and to inform members of new developments in the field.

In later years, when the need for skilled engineers really became apparent, many societies turned their efforts toward the organizing of branches for student use in the many engineering institutions. This made it possible for students to acquaint themselves with their future more than ever before. They could now keep up with professional developments and, at the same time, gain other valuable benefits from belonging to these societies.

It is only logical that in mingling with men who have established themselves in industry or education, many acquaintances should develop. Thus is the case. One who is introduced to an influential man can use that influence in procuring a position after graduation. In addition to this, he will meet fellow students and establish friendships of considerable value in the years to come.

No doubt, during the course of activities in a student branch of a professional society, some out-of-class friendships may develop between faculty and students. It is not intended to instigate the idea that these friendships should be used for the purpose of securing favors in class, but rather that the students and faculty will more likely understand each for mutual benefit.

Most organizations maintain a technical journal to convey information to the membership. This becomes a valuable aid to a student since it usually contains news of developments and employment trends in that field.

The author has listed only a few of the advantages of belonging to a professional society. They are all true and waiting for you to grasp them. The rest is up to you.

* * *

With the supply and demand curve for engineers looking somewhat like Dagmar's profile, it would be wise to give a word to the seniors that will be interviewed for jobs. Some helpful suggestions appeared in the May 1952 issue of the Villanova Engineer, a few of which are printed in the ensuing paragraphs.

Avoid flashy clothes! A simple plaid sport coat, conservatively pegged trousers (tunnel loops and pistol pocket flaps optional), tattersall vest, and tee shirt are recommended attire. Much thought should be given to the question of clothing and, while studiously avoiding loud clothing, it is well not to dress too conservatively. For example, in some quarters, wearing shoes is reguarded as evidence of stereotyped thinking and the prospective employer might well decide that the applicant lacks imagination.

On to the interview proper!—as soon as the introductions are over tell him to get to the money. This gambit will immediately impress him with the fact that you are no time-waster, but one who gets right to the heart of the matter. You will impress him as a man of action. He will appreciate this.

The next point is very important and cannot be stressed too earnestly. TURN DOWN THE FIRST OFFER! (The one exception to this rule is in the unlikely event that you are offered a drink.) To do this properly, you should recoil slightly in horror, wrinkle the nose as when passing a smouldering dump, and shout in a hoarse voice, "Are you crazy?" For a minute he'll think he is. This is your cue to switch the trend of conversation to a consideration of "working conditions"—a definite misnomer.

This bit of strategy tends to keep the employer on the defensive, while at the same time letting him think that you are really interested and he is getting through to you. Since employers dearly love to brag about working conditions, you'll have to be on your toes to keep him off balance. In 72 per cent of the cases reviewed by the panel, little posers like these proved effective: 1. "How long for lunch?" (hint: when he answers, say, "Humph!"). 2. "Air conditioning?" (if he answers no, shake head slowly; if yes, say, "O-oh, colds"). 3. "What time do we start work?" (no matter what he says murmur softly, "That's pretty early").

In concluding the interview, endeavor to leave the impression that you're interested but not quite sold on the job. Offer to call back in "a few weeks."

PHYSICS DEPT . . .

(Continued from page 11)

areas. These are nuclear physics and solid state physics. The University is very active in both of these fields and has an especially outstanding group of men in the latter. Professor Bardeen of the solid state group is recognized as a co-inventor of the transistor. This is a device used as a substitute for the vacuum tube. On many projects, the Physics Department works in close association with other departments of the University. Several men on the Physics Department staff have joint appointments, being also affiliated with the metallurgy chemistry, biology, or electrical engineering departments. An outstanding example of inter-department cooperation is the recent work done by the Electrical Engineering, Mathematics, and Physics Departments in the construction of a mammoth digital computer.

A large portion of the Physics Department's equipment is never seen by the undergraduate student in Engineering Physics. This portion is considered so elaborate and intricate in design that only thoroughly trained men are allowed to operate it. Nevertheless, a great many jobs in and around the physics laboratories are available to physics students on an hourly basis. It is on these jobs that the physicist can acquire practical training which will be of great value to him upon graduation.

We must realize that the Engineering Physics curriculum is only one of many activities administered by the Physics Department, and that the scope of the department encompasses many other fields of endeavor in both research and instruction.

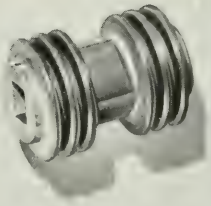
"More Power to You—Safely, with SYNTHANE"

Electrical energy is restless . . . would jump at any chance to escape—if it could.

The fact that voltage can be stepped up for transmission, stepped down for use; that current can be led to and from transformers, around switchboards, and steered into circuits safely you may credit to electrical apparatus builders. Important materials to them are Synthane laminated plastics.

Synthane laminated plastics are used in transformers for spacers and coil forms because it is an insulator unaffected by oils; in tap changer panels because it is a machinable insulator with high dielectric strength; in "Glowtectors" because of high insulation resistance and abuse-resistance; in circuit breakers and bus bars for its arc resistance.

Synthane, an unseen essential to power generation, transmission, and control, may be helpful to you. Send for your copy of the Synthane Catalog and learn all about Synthane's combination of electrical, chemical, physical and mechanical properties. Synthane Corporation, 10 River Road, Oaks, Pennsylvania.

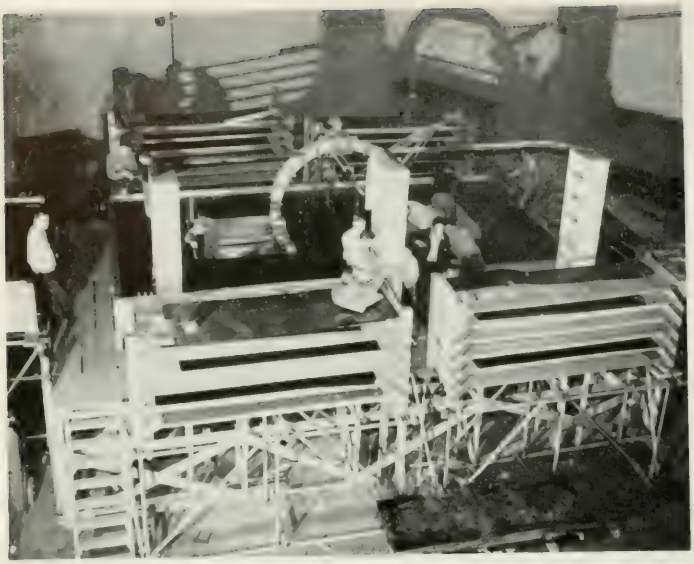


PETTICOAT STANDOFF INSULATORS machined from Synthane square-hole tubing. Here, Synthane was specified for its good dielectric properties, machinability and rugged strength.

Synthane-one of industry's unseen essentials

SYNTHANE

LAMINATED PLASTICS



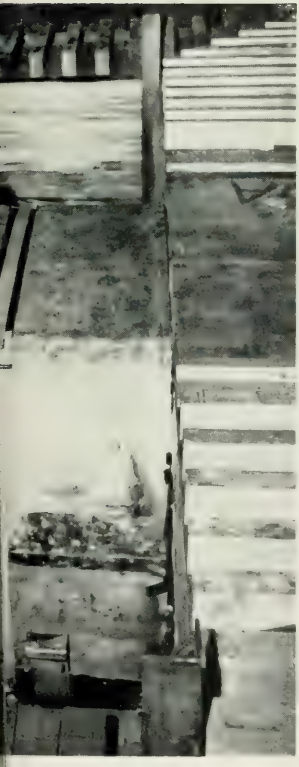
U.
Beta

Above: Laying magnet laminations for the University of Illinois' 300 mev betatron. Below: The control panel of the betatron with F. L. Peterson at the controls with Professor Kerst.

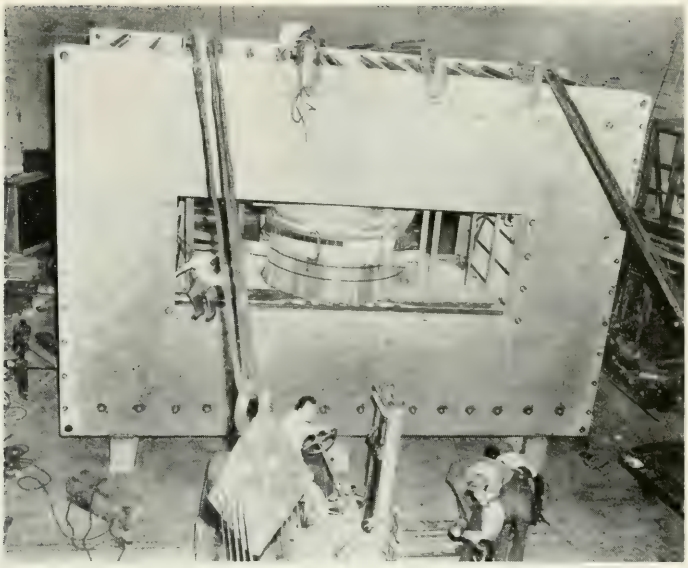
The main coil in the 3

f I.

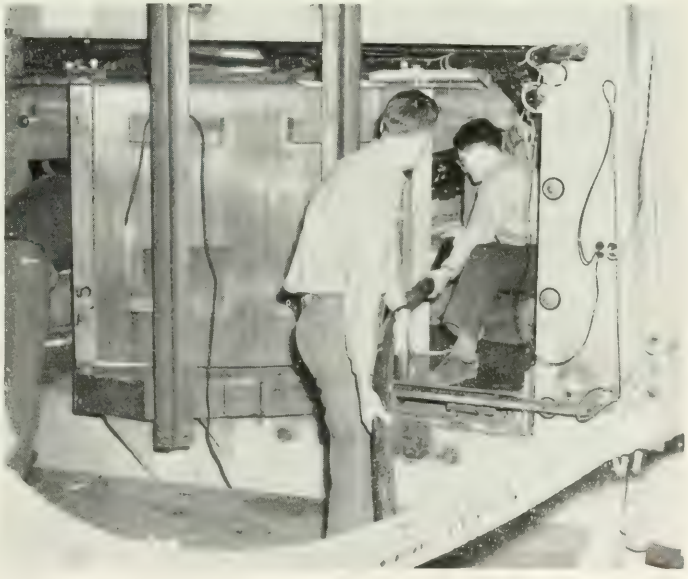
ron

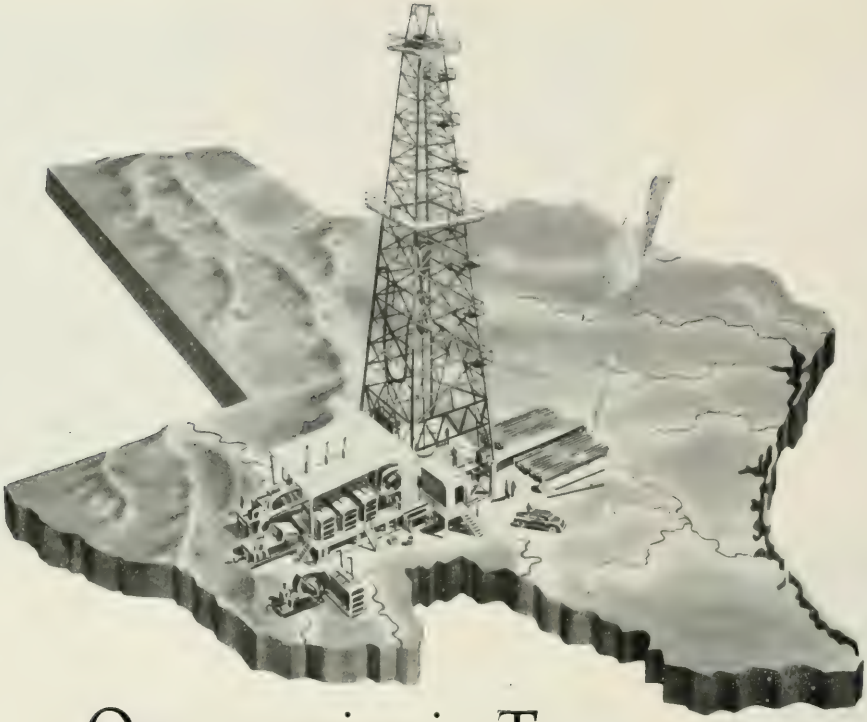


electron volt betatron.



Above: Turning the magnet of the University's betatron during its construction. Below: Installing the coil for the field magnets of the betatron.





Opportunity in Texas

Young engineers, geologists, chemists and physicists find major opportunities in the oil industry, and no state is more important to the industry than Texas.

Proven oil reserves in Texas are 56 per cent of the U. S. total. Texas produces about 45 per cent of U. S. oil from some 130,000 producing wells. Petroleum pipe lines in Texas total 46,000 miles. And Texas oil refineries have a daily capacity of two million barrels.

The search for oil; the drilling of oil wells; oil production, transportation and refining, all require increasing numbers of young men with engineering and scientific educations. Careers in the oil industry offer better than average material prospects, and what's more, they offer work that is productive, useful and satisfying.

HUMBLE OIL & REFINING COMPANY

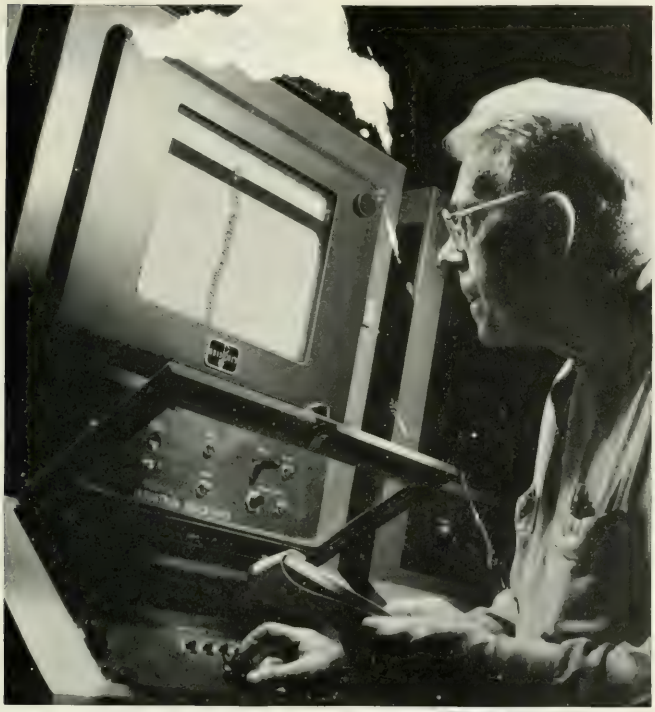
P. O. BOX 2180 • HOUSTON 1, TEXAS

HUMBLE

The Humble Company carries on Exploration Work in nine states—Alabama, Arizona, California, Florida, Georgia, Louisiana, Mississippi, New Mexico, and Texas . . . Wells Drilled by Humble total 1,200—1,500 annually . . . Crude Oil Production averages more than 380,000 barrels daily . . . Oil and Gas Production Taxes total about $18 million annually . . . Refining Operations of 270,000 barrels of oil daily are centered at Baytown, Texas . . . Retail Sales Activities are confined to Texas and New Mexico. Humble is the leading Texas marketer . . . Humble Pipe Line Company operates 5,895 miles of crude oil and product trunk lines in Texas and New Mexico and transports an average of 722,000 barrels per day of crude oil and finished products.

"MAN-MADE MINERALS"

contribute immeasurably to life's pleasures...



MAINTAINING UNIFORM HIGH QUALITY OF CARBORUNDUM abrasives is the process under observation here. Beta-ray gauges, the first ever installed by any abrasives manufacturer, have been adapted by CARBORUNDUM engineers to assure constant uniformity of product, vitally essential in such critical operations as the polishing of television picture tubes to provide a brilliant, distortion-free image.

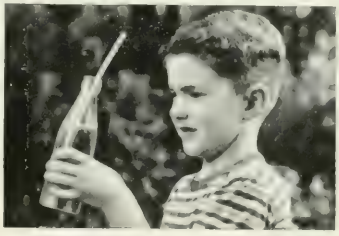
A process of the Coated Products Division

THIS PORTABLE OUTDOOR ROTISSERIE is equipped with GLOBAR electric heating elements made not of metal but of "man-made minerals." These elements reach maximum heat in seconds, thus help seal in meat juices for moist, succulent, tender steaks and roasts.

Heating Elements made by the GLOBAR Division

AUTOMOBILE MASS PRODUCTION owes much to "man-made minerals." A remarkable form is FERROCARBO, a deoxidizer used in many metallurgical processes. Added to the molten metal, this product by CARBORUNDUM produces metal that yields stronger, cleaner, easier-to-machine castings, of which the motor car industry utilizes millions.

Product of the Bonded Products and Grain Division



SOFT DRINKS travel safely to eager consumers in glass bottles—are more inviting in glass that's free from discoloration, flaws and bubbles. Leading bottle makers get this product quality, since their melting tanks are lined with MONOFRAX fused cast refractories. More important, they get product *quantity*... longer tank life that means extra months of service, extra thousands of tons of glass.

Produced by the Refractories Division

"The pleasant life" is vastly more pleasant today than ever before—in large measure because of the "man-made minerals," silicon carbide and aluminum oxide by CARBORUNDUM. These products of the electric furnace have been put to work in an infinite variety of ways to lower the cost of luxuries and necessities alike, and so to make them available to more and more people.

Wherever you find a product which has been formed, shaped, drilled, enameled, baked, painted, polished or sharpened, you can be sure it's been helped on its way to market by the "man-made minerals" pioneered by CARBORUNDUM. Equally so wherever you find a process involving diffusion, filtration, resistance to heat, chemical attack, corrosion, abrasion.

The unique properties of these materials are opening new industrial frontiers. Your inquiry to CARBORUNDUM is invited —whether you are a potential customer of CARBORUNDUM or a potential member of our great engineering staff.

Keep your eye on

CARBORUNDUM

TRADE MARK

for significant developments based on "man-made minerals"

THE CARBORUNDUM COMPANY, NIAGARA FALLS, N. Y.

Products by CARBORUNDUM include Grinding and Cutting-Off Wheels, Discs and Sticks...Coated Abrasive Sheets and Belts...Waterproof Abrasive Paper... Abrasive Grain and Powders and other abrasive products...Electric Heating Elements and Ceramic Resistors...Grain and Briquettes for deoxidizing steel and iron...Super Refractory Bricks, Special Shapes and Cements...Porous Filter Media and Diffusers—and are marketed under the following trademarks:

CARBORUNDUM • ALOXITE • MX • RED-I-CUT • TEXALOX • GLOBAR FERROCARBO • CARBOFRAX • ALFRAX • MONOFRAX • MULLFRAX

production of . . .

The Illinois Technograph

by George Ricker, A.E., '49, and Sam Jefferies, E.E., '48

This article, like all other articles in this magazine, was in its first stage of preparation twelve weeks ago. Since then, it has seen all the different phases of editing by students; composition of the complete magazine from the articles, short items, illustrations, and advertisements; printing by the Illini Publishing company; and distribution by the business staff, composed entirely of students. In fact, that is what this article is about—its own preparation.

The *Technograph* staff is composed of engineering students who are interested in writing and editing or in the business procedures of publishing and distributing a magazine. These activities are an absorbing hobby to the student, and the student gains valuable experience by his participation.

The preparation and writing of an article, and the development to its final form are the duties of the editorial staff, which is directed by the editor. The editor and the assistant editors decide upon the articles and illustrations which will appear in each issue.

After the articles and illustrations for the issue have been chosen, the assistant editors make the assignments to the reporters. Usually one or sometimes two reporters are assigned to a feature or department, and generally have about four weeks to meet the deadline.

For the initial preparation, the reporter determines the scope of his subject and gathers general information. He then makes a rough outline of the subject and selects the material that will be covered. He investigates all sources of information. The business of getting first-hand and up-to-date news on the subject is an interesting part of the reporter's work. This includes interviewing, investigation, and obtaining contemporary literature on the subject. All this work is preliminary to the actual writing of the article.

While the reporters are gathering information and writing the articles, the make-up editor determines the types of pictures to accommodate the articles and makes assignments to the staff of photographers. The photographers have the job of getting pictures that are not only technically illustrative, but that also show good photographic composition. Photography is an art in itself, and is a hobby to these men. Certain types of pictures, like commercial products, are obtained directly from their source. The make-up editor must meet the same deadline as the reporters.

After all copy has been turned into the office by the reporters, the articles are edited. They are reviewed and revised, and necessary changes are made to improve the form and composition and to conform to the particular style used by the magazine. Each assistant editor checks over the material turned in by the reporters under his supervision, and the editor then reviews all the copy. The edited copy is then taken by the editor to the Illini Publishing company for processing.

At the same time that the copy is being edited in the office of the Technograph, the make-up editor and the editor are marking up the illustrations for size. These photographs are then taken to G. R. Grubb and Company to be engraved. The production of a metal plate suitable for printing the varying tones of a photograph is an interesting process.

The first step in engraving is the production of a "half-tone" negative. The illustration is "shot" through a half-tone screen by taking a photograph of the illustration with a half-tone screen placed upon the negative. The half-tone screen consists of two plates of glass, each striated by a diamond cutter, placed one upon the other so that the unit is cross-hatched. The striations are very fine grooves which are filled with a black pigment. The half-tone screens used in making plates for this magazine have 120 grooves to the inch, and therefore 120 times 120 squares to the square inch. When the light from the picture passes through this screen to the negative in the camera, the light is refracted so that the square is reduced in size on the negative. These squares on the negative are larger for greater intensity of light, which corresponds to a lighter tone of gray. The resultant negative of minute squares is called a half-tone negative.

The half-tone negative is next printed onto a metal plate covered with a photosensitive enamel. This plate is developed and a half-tone print of enamel is left on the metal. The plate is now etched, so that the parts not coated with enamel become the depressed portion of the engraved plate, or cut. The metal plate from which the cut is made is usually a zinc or copper plate, and brass is sometimes used to produce a tough plate. Copper is etched with hydrochloric acid, zinc is etched with perchloride of iron, and brass is usually electrically etched. From G. R. Grubb's finishing department, the cuts go to the Illini Publishing company.

The Illini Publishing company is a non-profit organization which was established in 1911 to print and distribute The Daily Illini and other student publications of the University of Illinois, and to do a general printing and publication business. All proceeds from the business of this non-profit organization go back into the reserves of the company and are used to further improve the publications. This company is subject to the general authority of the president of the University. The *Technograph*, The Daily Illini, The Illio, the Agriculturist and the Tempo are all published by the Illini Publishing company.

At this point the edited copy is ready to be marked up in the printing shop of the Illini Publishing company. In the margins of the copy are marked the type face, size of type, and measure of the width of the column to guide the setting of the copy by the operator of the linotype machine. These linecasting machines used by the Illini Publishing company are Intertypes.

There are two main steps in composition, or setting copy. The first is the line casting on the Intertype. When the

(Continued on page 38)

Note for a faculty member's briefcase!

Recently we had the pleasure at General Motors of welcoming 19 faculty members from leading engineering schools to Detroit.

This was part of our continuing effort to discover ways in which GM can be of help in furthering the growth of engineering education in America.

And their professors informed us that they would welcome information on General Motors employment opportunities which they could pass along to their students.

In the thought, therefore, that other faculty members may share their opinion, we are publishing this message.

So we would like you to know these few simple facts about GM job opportunities.

1. They are broadly assorted—fitting a wide range of talents—from the pure scientist to the young man who sees in his engineering training a fine background for production or management work.
2. They cover a wealth of subjects—from chemistry and chemical engineering to mechanical and electrical engineering, from metallurgical engineering to industrial engineering.
3. They offer reasonable advancement for the diligent and ingenious mind. For the industrial climate at GM is conditioned by a traditional respect for the engineering point of view. Witness the number of key GM executives in both divisions and top management who began their careers as engineering graduates on GM drafting boards.

And we would like you to feel free at any time to write us, or ask our College Representative, who periodically visits your campus, any detailed questions on the subject of GM jobs for your talented students.

GM POSITIONS NOW AVAILABLE IN THESE FIELDS:

Mechanical Engineering
Electrical Engineering
Metallurgical Engineering
Industrial Engineering
Chemical Engineering

GENERAL MOTORS

Personnel Staff
Detroit 2, Michigan

TECH . . .

Continued from page 36

operator presses a key on the keyboard of the Intertype, a mold for casting a letter, called a matrix or "mat," is released and drops into line. The type metal, which is a mixture of zinc, lead, tin, copper and antimony, is kept in a molten state, ready to be cast into a line of type or slug. When a line of mats is ready for the casting of the slug, the molten type metal is forced against the mats and into the depressed letters in the face of the mats. When it cools, a line of type, or slug, is ejected from the machine. The second step in setting copy is the assembling of the slugs into columns of type. Such a column of type is called a galley.

Proofs must now be pulled from the galleys on a proof press. To do this, the galley of type is placed on the proof press, the type is inked, the paper placed directly on the type, and a roller moved over the paper. Two proofs of each galley are pulled, and sent to the *Technograph* office for the correction and for making up the magazine dummy. The dummy is a rough assembly of the entire magazine, formed by cutting parts from the galley proofs and pasting them along with the illustrations and headlines on the pages of an old magazine. This work, which requires approximately a week, is done by the make-up editor, assisted by the editor. The completed dummy is then turned over to the printer for make-up of the pages of type.

After the typesetter has corrected the galleys, and the headlines have been set either on a Ludlow line casting machine or by hand, the printer assembles the body type, headlines, and cuts (engraved illiustrations) into page forms, according to the pages of the magazine dummy. In the print shop, this operation is called makeup. One proof of each page is then pulled and returned to the *Technograph* office for correction. These proofs are checked and corrected first by the editorial staff and then by the editor assisted by the make-up editor, and are then returned to the printer. In the print shop, corrections are made on the page by substitution and by resetting type. The pages are then locked up in forms, or chases, of eight pages each, constituting what is known as a printing signature. There are forty-four pages in this magazine, and four printing signatures of eight pages each and two signatures of four pages each are used on the printing press. The pages are arranged in these printing signatures so that, when the paper is printed and folded, the pages will be in order that they are to appear in the magazine.

The Illini Publishing company uses a flat-bed, cylinder press. The printing signatures are locked on the bed of the press, and the press makes the printed impression by rolling the paper, held to a cylinder by grippers, between the cylinder and the signature chase, over the type. The type is inked by a roller prior to each contact with the paper. The paper used for this magazine is a 70-pound, coated, enamel book paper. A sheet of paper, printed on both sides and containing sixteen printed pages, is called a binding signature. Before being bound, these binding signatures are placed on trays to dry because the ink used is job ink which must dry by oxidation.

When the pages have dried for about twenty-four hours, the binding process begins. The signatures are fed into a Dexter folding machine. This machine can be rigged-up with tapes for a variety of page sizes and folds, and for the sixteen-page binding signature of this magazine, it is set to fold the paper three times. Then all groups of pages are assembled into the proper sequence by page and number and the cover is wrapped around the signatures. The assembled magazine is then stapled together with a saddle stitch, and the magazines are then trimmed with a power cutter.

Sixty magazines are trimmed simultaneously on the power cutter. As a safety measure the operator of the power cutter must manipulate two releases at the same time, one on each side of the machine, in order to allow the blade to descend. The magazine is usually trimmed to 8½ by 11⅝ inches, but the trim size is often altered slightly to "bleed" an advertisement on the cover. A "bleed" ad has a picture that extends all the way to the edge of the cover, consequently, the magazine must be trimmed properly to bleed the advertisement. After the magazines are trimmed, they are ready to be distributed by the circulation department.

The life span of a publication would, without a doubt, be snapped short if it were not distributed promptly to its readers. This is why every publication organization which hopes to have more than one issue has a circulation manager. It is the circulation manager's job to see that all of the magazines are mailed and distributed to the proper persons and that the subscription sales are carried through—down to the last ounce of energy.

In order to take a big load off the clerks at the post office, the magazines are wrapped and mailed in four groups.

Continued on page 48)

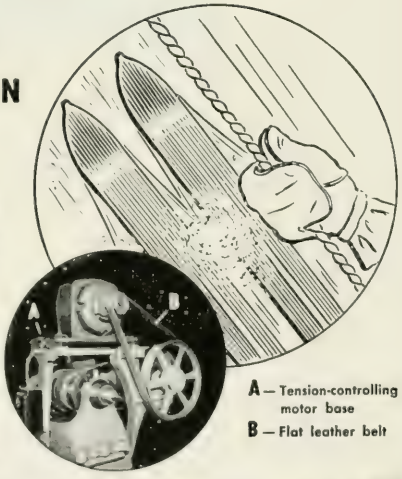
FOR THE LONG PULL...

IT'S LEATHER PLUS TENSION CONTROL

On the ski tow it's the leather grip of your ski mittens plus tension controlled by your hands that helps you get the most out of power.

In modern industry, the UNI-PULL short center drive uses leather belting and tension control for long, trouble-free power transmission.

That's part of the reason why today there are more leather belt drives in industry than ever before.



AL-55

American LEATHER BELTING Association

Headquarters for Authentic Power Transmission Data

320 Broadway, New York 7, N. Y.

to the

ELECTRICAL ENGINEER

or

PHYSICIST

with an interest in

RADAR

or

ELECTRONICS

Hughes Research and Development Laboratories, one of the nation's leading electronics organizations, are now creating a number of new openings in an important phase of their operation.

Here is what one of these positions offers you:

THE COMPANY

Hughes Research and Development Laboratories, located in Southern California, are presently engaged in the development and production of advanced radar systems, electronic computers and guided missiles.

THE NEW OPENINGS

The positions are for men who will serve as technical advisors to government agencies and companies purchasing Hughes equipment—also as technical consultants with engineers of other companies working on associated equipment. Your specific job would be essentially to help insure successful operation of Hughes equipment in the field.

THE TRAINING

On joining our organization, you will work in the Laboratories for several months to become thoroughly familiar with the equipment which you will later help users to understand and properly employ. If you have already had radar or electronics experience, you will find this knowledge helpful in your new work with us.

WHERE YOU WORK

After your period of training—at full pay—you may (1) remain with the Laboratories in Southern California in an instructive or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the Hughes representative at a military base in this country—or overseas (single men only). Compensation is made for traveling and moving household effects, and married men keep their families with them at all times.

YOUR FUTURE

In one of these positions you will gain all-around experience that will increase your value to our organization as it further expands in the field of electronics. The next few years are certain to see large-scale commercial employment of electronic systems. Your training in and familiarity with the most advanced electronic techniques now will qualify you for even more important future positions.

How to apply:

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Engineering Personnel Department
Culver City, Los Angeles County, California

See your Placement Office for appointment with members of our Engineering Staff who will visit your campus. Or address your resumé to the Laboratories.

Graduate Engineers!

ENJOY GOOD SALARY FROM THE FIRST DAY... INTERESTING CHALLENGES RIGHT AWAY!

At Sperry you can apply your knowledge immediately and keep on learning with pay—in research, product development, or field work. Salary increases come as you progress.

You enjoy the advantages of working with the leaders in their fields. You are expected to use originality and a fresh approach. Every project is a creative challenge to the brain-work and the team-work of the Sperry engineering staff.

VARIETY OF OPENINGS

There are opportunities for aeronautical, electrical, electronic, mechanical engineers – physicists – technical writers and field engineers for applied engineering.

ATTRACTIVE LOCATIONS
GOOD WORKING CONDITIONS

Long Island—In pleasant suburban atmosphere but convenient to New York. Modern plant. Well equipped laboratories. Excellent working facilities.

In the Field—There are excellent applied engineering opportunities in various sections of the United States and abroad.

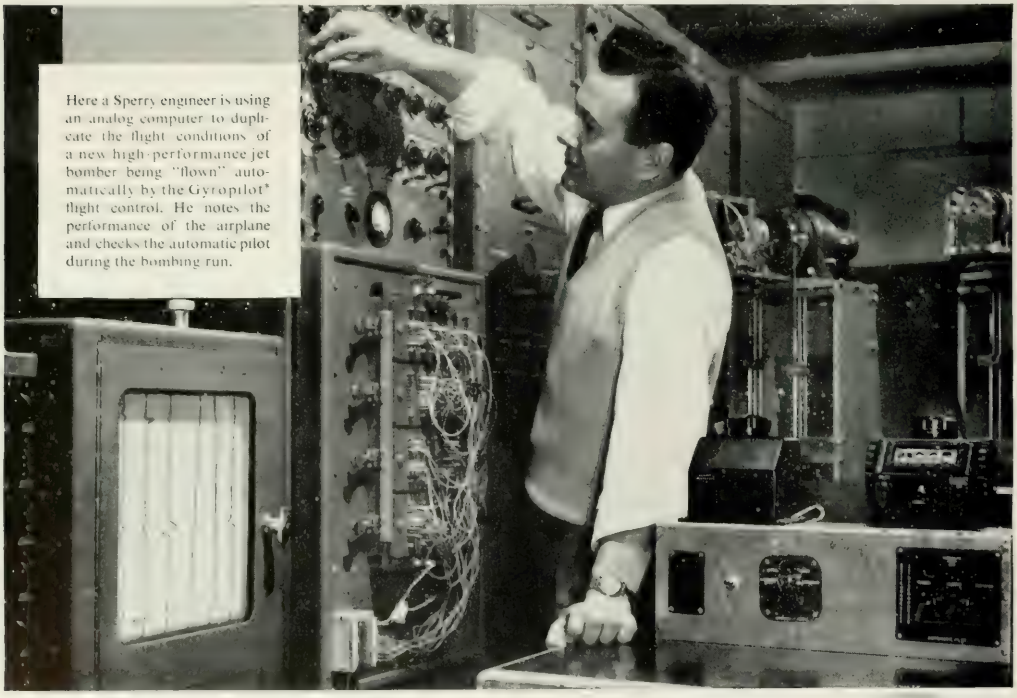
In All Locations—The way is clear for steady advancement. You are encouraged to continue your education while you earn. And liberal employee benefits are provided for all.

RESEARCH LEADERSHIP...
A FORTY-YEAR TRADITION

Today Sperry is the recognized leader in developing automatic controls for navigation. From Sperry's work in gyroscopics and electronics have come the Gyropilot® flight controller, Zero Reader® flight director, radar, servomechanisms, computing mechanisms and communications equipment.

Sperry sponsored the development of the klystron tube—the first practical source of microwave energy. From Sperry pioneering has come a complete line of Microline® instruments for precision measurement in the entire microwave field.

CHECK YOUR PLACEMENT OFFICE FOR DATES WHEN SPERRY REPRESENTATIVES WILL VISIT YOUR SCHOOL...OR WRITE SPERRY EMPLOYMENT SECTION 1A5.



Here a Sperry engineer is using an analog computer to duplicate the flight conditions of a new high-performance jet bomber being "flown" automatically by the Gyropilot® flight control. He notes the performance of the airplane and checks the automatic pilot during the bombing run.

® M. REG. U. S. PAT. OFF.

SPERRY GYROSCOPE COMPANY
DIVISION OF THE SPERRY CORPORATION

GREAT NECK, NEW YORK · CLEVELAND · NEW ORLEANS · BROOKLYN · LOS ANGELES · SAN FRANCISCO · SEATTLE
IN CANADA – SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

Takes a lot to lay a carpet in the jungle

The scene is "darkest Africa".

But Africa is lightening. Man's quest for minerals, for new areas for agriculture and trade, is slashing ultra-modern, glaring-white air strips in once impenetrable jungle.

Those pavers, portable air compressors, pumps and air tools—such as you might see working a city street—are Worthington Blue Brutes going to "lay a carpet" in that hole in the jungle.

Thus, Worthington, a major producer of equipment for public works, industry and farm, brings the fruits of American technical genius to the strange places of the world.

And illustrates, too, how the unique American talent of *diversification* helps public, employees and stockholders. For Worthington makes many things—not just construction equipment and pumps, but also engines, water works machinery, power transmission, petroleum equipment, air conditioning and refrigeration, many others.

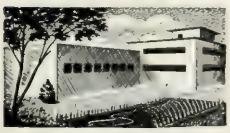
Such diversification builds *stability* . . . makes Worthington, 112 years old, a strong link in the chain of American business.

Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Harrison, New Jersey.

WORTHINGTON

The Sign of Value
Around the World

1.14



Good Water and Sanitation—engines pumps · water treatment · comminutors air compressors · air tools

Lower-Cost Manufacturing—pumps compressors · steam turbines · motors power transmission · air conditioning

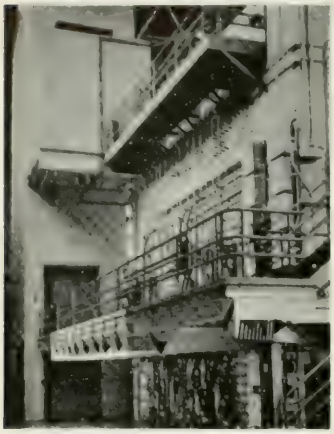
Petroleum Products—compressors engines · pumps · chilling equipment refrigeration · decoking systems

More Abundant Food—compressors fertilizer mixers · air conditioning refrigeration · pumps

BROOKHAVEN . . .

(Continued from page 17)

foot smokestack. If, perhaps, too much radiation should be diffused into the air, one of several 420 foot meteorological stations in the area would detect it. Only two or three times since the pile started operations two years ago has it had to be shut down because of this.



Brookhaven reactor's north face contains a pneumatic tube system used to render materials radioactive.

Safeguarding the workers themselves are sixteen stations that automatically monitor radioactivity. The instrument which performs this service, developed by Brookhaven's scientists, collects dust on a filter and scans it for radioactivity. Every six minutes a camera photographs the readings of all these instruments. In addition, floor and table surfaces are checked periodically for contamination, and the staff members who work with the radioactive materials have a double locker room in order to keep their street clothes and work clothes separate.

Any individual who works in possible dangerous areas has his hands and feet clocked when he checks out. Every worker carries two pencil shaped instruments in his shirt pocket (one in case the other goes bad). They contain wire which is analyzed at the end of the day for possible exposure. Also there are badges containing film, which, if exposed, may indicate excessive exposure. As yet no one has suffered severe enough radiation effects for hospitalization.

For some reason, no one seems to be interested in investigating the wonders of this marvelous development. When Brookhaven holds its annual open house, the crowd is small. In large part it consists of children escorted by their science teachers. Possibly because it is the Atomic Energy Commission's most accessible installation, people do not consider this "doorway to the future" important.

INTRODUCING . . .

(Continued from page 16)

him success in the future, which we know will be his.

DR. R. H. ALMY

Dr. G. M. Almy, Associate Head of the Physics Department, came to the University of Illinois in 1930. Dr. Almy received his Bachelors Degree and Masters Degree at the University of Nebraska and his Doctors Degree at Harvard. Immediately following, he started to work at the University of Illinois. Dr. Almy is a member of the

DR. R. H. ALMY

Sigma Zi Honorary Scientific Society and the Phi Beta Kappa Scholastic Honorary Fraternity. He also helps sponsor the Physics Club at the University of Illinois. Approximately sixteen Ph.D. theses have been under his supervision.

During World War II Dr. Almy worked in co-operation with Allis Chalmers for the Office of Scientific Research and Development. The purpose being the study of radiography by means of the betatron. An important development result from the co-operation with Ralph Hursh of the Ceramic Engineering department. This, being an air tight vacuum tube made of porcelain, put an end to the need of constant pumping.

Dr. Almy believes that despite its very rapid advancement, the field of engineering requires relatively few fundamentals of science and mathematics.

● LEROY* Lettering equipment is standard in drafting rooms everywhere. No special skill is needed for perfect, regular lettering and symbol drawing. There are LEROY templates in a variety of alphabets and sizes, as well as for electrical, welding, map, geological, mathematical and other symbols that the draftsman needs. *Trade Mark®

KEUFFEL & ESSER CO.

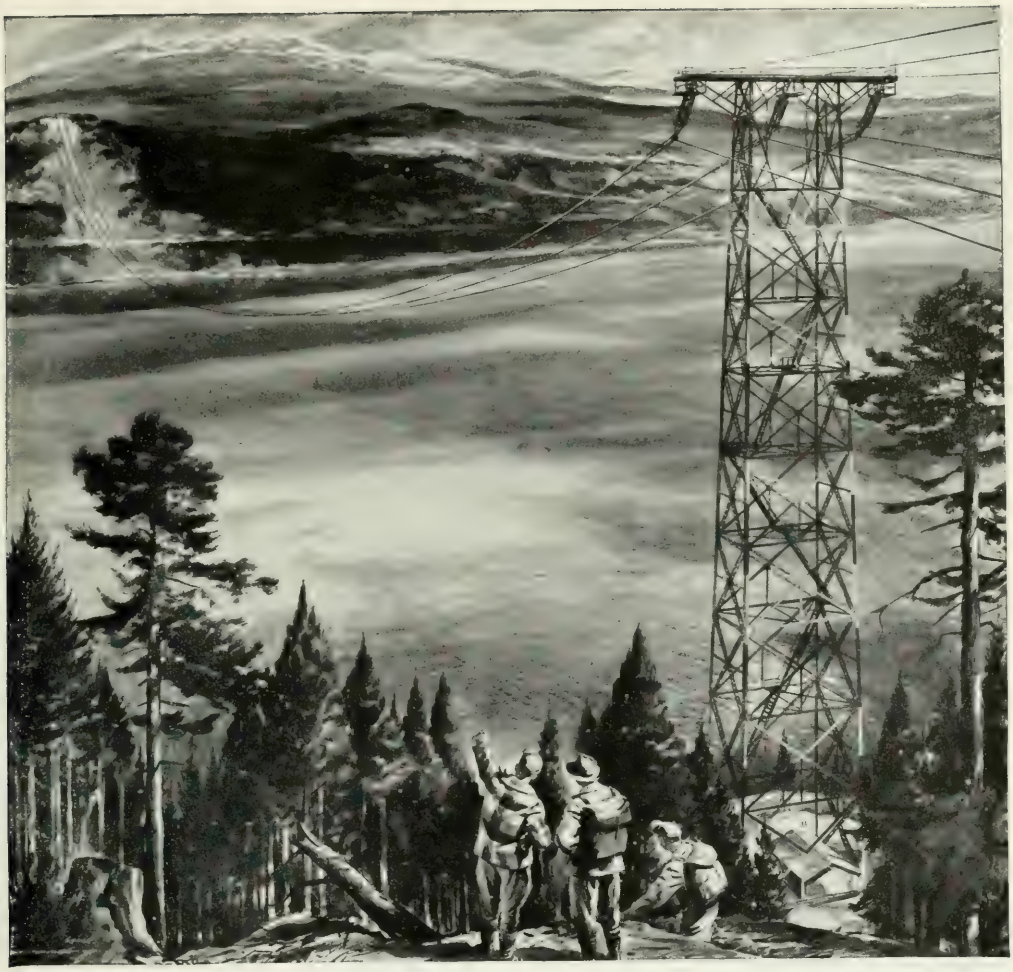
EST. 1867

NEW YORK • HOBOKEN, N. J.

Chicago • St. Louis • Detroit • San Francisco • Los Angeles • Montreal

K+E

Drafting, Reproduction and Surveying Equipment and Materials, Slide Rules, Measuring Tapes.



LONGEST SPAN IN THE WORLD

IN BRITISH COLUMBIA the longest span in the world has been completed. More than two miles in length, it crosses Lake Kootenay and is part of an electrical transmission line of the Kootenay Light and Power Company.

The span consists of three cables, each an inch and a quarter in diameter. At the west side of the lake, the cables are suspended from three 80-foot towers located on a high bluff. On the lower east shore a single 375-foot tower is used.

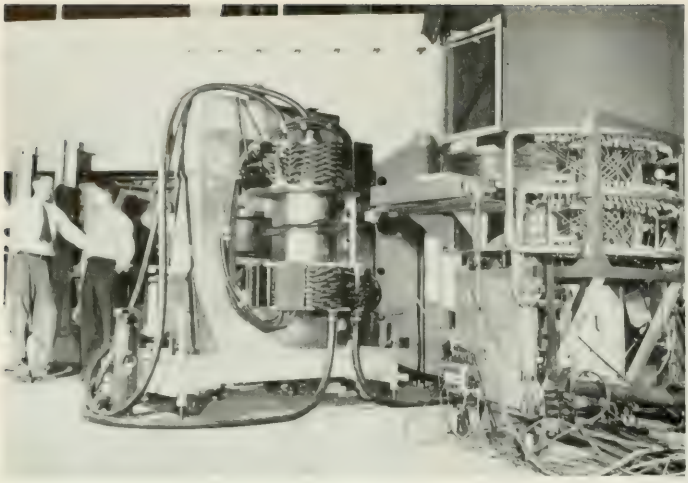
The tailor-made cables were designed for high strength and light weight by Roebling. High tensile Roebling steel wires were used because other conductive materials would collapse from their own weight in a two-mile span.

Roebling was outstandingly qualified to meet the requirements of this history-making installation. Through every manufacturing process, Roebling's steel mills and wire rope plants were backed by the engineering resources of its Electrical Wire and Cable Division and the unparalleled experience of the Roebling staff in the design and construction of suspension bridges.

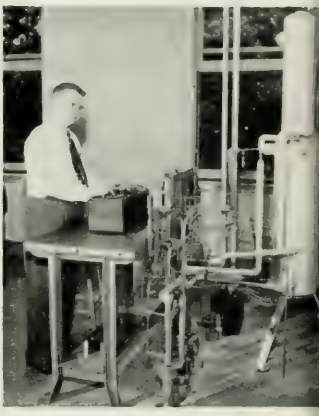
We are proud that in the Kootenay span we have helped achieve another engineering "first"... and that the full range of Roebling wire and wire products is helping industry in the huge emergency production task which it is doing so well. John A. Roebling's Sons Company, Trenton 2, New Jersey.

ROEBLING

Resea
Universit



Above: Cloud chamber research with 300 mev betatron. Chamber at right, screening magnet in center, betatron in rear. (l. to r.) Professor Donald W. Kerst, C. Robert Emigh. Below: Professor Ralph E. Meagher examines one of the 40 cathode-ray tubes which composes the memory of the ORDVAC. The ORDVAC is an electronic digital computer built by the University for Ballistical Research Laboratories at Aberdeen, Maryland.

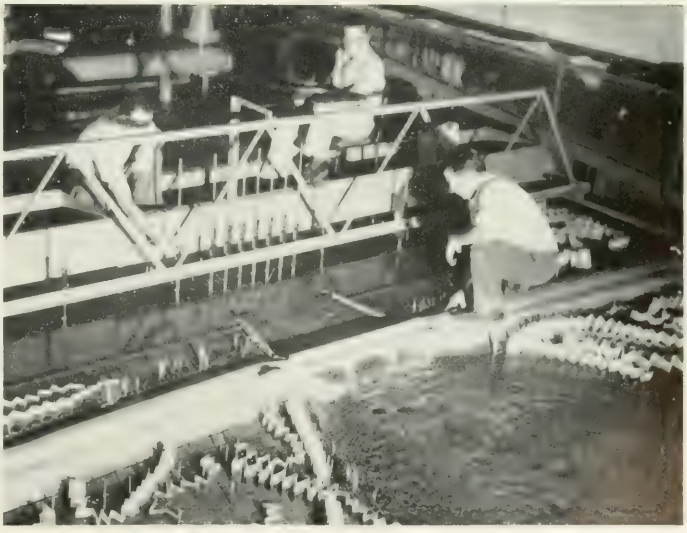


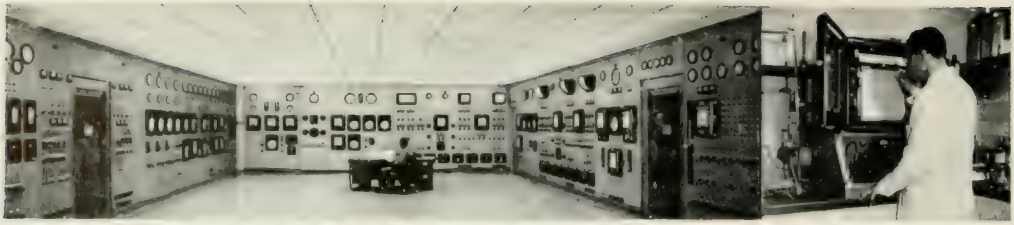
Professor F. G. Ctraub with 3-foot-high pressure bioler for boiler research.

at the
f Illinois

rofessor John C. Guillou inspect-
ng a new highway drainage gate
esigned by research at the U. of
It admits twice as much water as
id old design and will save $500,-
00 on Chicago Congress super-
ighway alone.

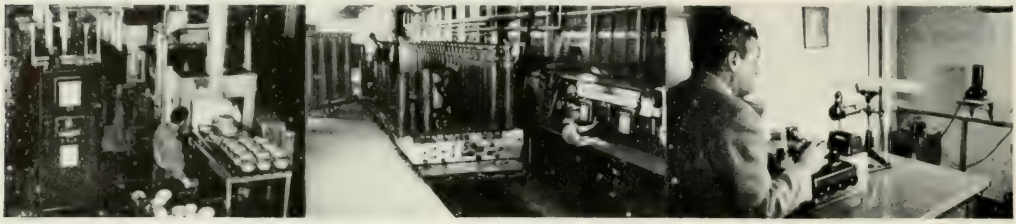
Above: Professor Kerst with the original betatron which he constructed at the University of Illinois in front of the new betatron. Below: Model of Illinois Highway 460 bridge over Wabash river flood plain built by U. of I. engineers who found way to tame eddy which threatened to drop bridge into 40-ft.-deep hole by constructing dikes 100 ft. upstream to direct the water under the bridge.





L&N instruments "From Coal Pile to Bus Bar" in central station's control room

Electro-Chemograph



Speedomax control on annealing furnace

Speedomax control of ceramic kiln temperature

Research with K Potentiometer & accessories

Speedomax instruments in a refinery

Homocarb furnaces in auto plant

Aircraft testing

Like to Play a Part in Scientific and Industrial Progress?

• Because instruments are basic both to industrial and to scientific work, the instrument field ranks high in opportunity. As long as men make pig iron or pills, guns or butter, rockets or kilowatts or gasoline, industry will use more and more instruments on the production line. As long as scientists "unscrew the inscrutable" they will need instruments for college, Government and industrial research.

As a result, L&N job opportunities are quite varied. Openings in sales engineering utilize technical training in the examination of processes, and in selection and application of correct instruments in industrial plants. Other openings are in research, product development, production, advertising, inspection and other operations.

We make automatic, balance-type electrical instruments for controlling, measuring and indicating temperature, chemical concentration, combustion, frequency and load, flow and other conditions. We make heat-treating process equipments. We make laboratory-type instruments, in forms for scientists from freshman to Ph.D.-plus.

Our chosen portion of the automatic control and instrument field is in high-precision, high-dependability equipment. Commercially, we are one of the leaders; we have grown in every decade of our history, and continue to grow. And we are innovators; we pioneered many basic developments . . . are pioneering others, and will continue to do so.

Personnel-wise, the Company's policies are modern and progressive. We have long had group insurance, hospitalization, pensions and financial assistance for post-college education. Compensation includes profit-sharing as well as salary. L&N will continue to offer present opportunity and a substantial future.

Why not have a chat with our nearest District Office Manager? Or if you prefer, write our Personnel Manager, 4915 Stenton Ave., Phila. 44, Pa.

LEEDS **NORTHRUP**

instruments — *automatic controls · furnaces*

Atlanta, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Hartford, Houston, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, St. Louis, Tulsa

Jrl Ad ENT-560(1)

ME...
an AIRCRAFT engineer?

But I haven't majored in aeronautical engineering

That doesn't matter.
Lockheed can train you...
at full pay!

It's your aptitude, your knowledge of engineering principles, your degree in engineering that count.

Those—plus the opportunity Lockheed is offering you—are all you need for a career as an aircraft engineer. In Lockheed's special program for engineering graduates, you may go back to school, or you may convert to aircraft work by doing—on-the-job training. But whichever it is, you receive full pay while learning.

But Lockheed offers you more than a career. It offers you a new life, in an area where living conditions are beyond compare. Outdoor living prevails the year-'round. Mountains, beaches are an hour from Lockheed.

See your Placement Officer today for the details on Lockheed's Aircraft Training Program for engineers, as well as the better living conditions in Southern California.

If your Placement Officer is out of the illustrated brochures describing living and working conditions at Lockheed, write M. V. Mattson, Employment Manager.

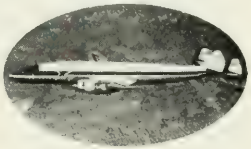
Lockheed Aircraft Corporation

Burbank, California

This Plane made History

The P-38 Lightning – first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History



The Super Constellation – larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

This Plane will make History

The jet of the future – the plane you will help create—belongs here.

This plane – which exists only in the brain of an engineer like yourself – is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.

TECH . . .

(Continued from page 38)

These four groups are mailed to Champaign, to Urbana, to Illinois, and to outside areas. The magazines in the groups which are mailed to Champaign and Urbana go to students and faculty. The third group includes magazines which go to the Navy Pier branch, and other readers in the state. The last group is composed of all the magazines which are sent out of the state. These *Technographs* eventually find their way to all parts of the United States and even to some foreign countries.

However, after these magazines have been mailed, there is still a large number left to be distributed to various places and people. Some of the *Technographs* are taken to the bookstores to be sold as single copies. Each firm that advertises in the *Technograph* is sent a free copy. Littrell-Murray-Barnhill, Inc., the company which handles the procurement of advertising from large companies, is sent several copies for its use. Engineering College Magazines Associated, of which the *Technograph* is a member, is the headquarters of allying association for twenty-seven engineering college magazines, gets twenty-six exchange copies. The copies are sent to the E.C.M.A. in exchange for a magazine from each of the other schools. The officers of the E.C.M.A. also get a copy of the *Technograph*. A large number of the *Technographs* are sent to high schools throughout the state through the support of the College of Engineering. A survey conducted last spring shows that the high schools are very appreciative of this service and that they desire to continue receiving the *Technographs*.

The third problem about which the circulation manager perspires freely is the subscription sales. The actual selling of the subscriptions is carried on by the entire staff during campaigns which usually take place at the beginning of each semester. The subscriptions are sold on a whole year or a half year basis. In order to boost the efficiency of the campaign, booths are placed in the engineering buildings and the sales are made from there. A periodical is very dependent on its circulation. It is not the money that it receives from a large number of sales that keeps a magazine aloft, but the advertisement that it can obtain because of a large circulation.

The advertisement carried on in the *Technograph* by large firms is handled by the general advertising manager. All of these advertisements are obtained for the *Technograph* and other engineering college magazines by Littell-Murray-Barnhill, Inc. The first notice that the *Technograph* receives of a company's desire to advertise is a contract from Littell-Murray-Barnhill, Inc. It is stated on the contract who is buying the advertisement, the price and size, and the issues the ad is to be run in the magazine. The contract, however, is not the order for the advertisement and the firm cannot be held to the contract. The actual authorization to run the ad is the insertion order. The order shows the purchaser what issue it shall appear in, the price and size, and an identification of the cut. The last thing to appear from Littell-Murray-Barnhill, Inc., is the ad itself.

A record is kept with a list of all the firms who have contracts to advertise in the *Technograph*. Each month this list is checked with the insertion orders, and the cuts to make sure that all of them are in our hands. If anything is missing, a letter is sent to Littell-Murray-Barnhill, Inc., to find out what happened.

At a scheduled time, the staff gathers up all the cuts and carries them to the printers. The staff then pulls two proofs of each advertising cut. One set is used in the dummy and the other set is checked out for errors. These proofs are returned to the printers at the same time the galley proofs go back.

The general advertising manager also has to make a report. The report must include who advertised in the magazine, and the size and price of the advertisement. This report has to be turned over to the Illini Publishing company along with a magazine which has the prices marked on each side of the advertisements. A list of the advertisers must also be supplied to the circulation manager so he can send a magazine to each of the firms.

The advertisements which are placed in the *Technograph* by local businessmen come under the jurisdiction of the retail advertising manager. This advertising is solicited by the personnel on the retail advertising staff. The first step in the procedure for obtaining these ads is to draw them up. The salesmen then visit the various businessmen to sell them the ad which was drawn up for their store. When the contract is made, the advertiser can either approve the advertisement as it is or fix it to suit himself. The ads are then turned over to the Illini Publishing company where they are made up in type form. After the printer pulls proofs of these ads, the advertiser has a chance to check his advertisement for errors before it goes to press. An extra set of these proofs is also returned to the office to be used in the dummy.

The retail advertising manager must also keep a record, make out a report, and send a list of the advertisers to the circulation manager, just as the general advertising manager does.

In every organization which expects to prosper, new ideas are born. The *Technograph* has its little baby also. This idea is the statewide advertising department. The purpose of this department is to get more Illinois firms to advertise and represent themselves in the *Illinois Technograph*. Although this department is still in its promotional state, a great deal of trouble has been taken to procure a list of prospects. Letters have been sent to some of these firms to acquaint them with the advantages of advertising in the *Technograph*. It is very possible that in the future this new idea will take the form of a permanent member on the *Technograph*.

Without advertising, a periodical cannot be published. Without circulation, there will be no advertising. Without publicity, there is no circulation. These three statements all add up to prove that publicity is a very important factor.

The publicity for the *Illinois Technograph* is handled by the circulation manager. Write-ups for the magazine, for the staff meetings, and for other publicity are carried in The Daily Illini, The News-Gazette, and the Champaign-Urbana Courier. The publicity comes from posters on the bulletin boards and the *Technograph* blotters. However, there are plans for widening this department considerably.

The laurels of this magazine rest on two men—the editor and the business manager. It is their duty to see to it that the above operations are carried out and co-ordinated, and only through co-operation of the entire student body will this magazine be able to keep up its great progress.

ELECTRONICS . . .

(Continued from page 9)

developed especially for this type of application. It is capable of multiplying feeble photoelectric current by an average value of 600,000 times, and its frequency response is flat up to about 50 megacycles.

The output of the pulse amplifier is fed into a 32 channel analyzer for pulse height analysis. The pulse height is proportional to the energy of single particles. Particles detected include gamma rays, beta particles and alpha particles.

Many new electronic devices such as the multiplier phototube referred to have been developed recently because of the inadequacies of older devices, like the geiger counter.

The geiger counter would indicate the presence of a particle, but it was very difficult to gather reliable information from it on the speed or energy

(Continued on page 50)

What Is this Machine?

- ☐ *a vertical miller*
- ☐ *a grinding machine*
- ☐ *a broaching machine*
- ☐ *a contour shaper*

It is a grinding machine — specifically, the new Norton Propeller Blade Hub Grinder, used to grind the external surfaces of the hubs of aircraft propeller blades

A Typical Norton Development

This specialized Norton machine brings unusual efficiency to propeller grinding operations. As shown, the propeller blade is held *vertically* — by a workholding fixture on a work spindle with an anti-friction bearing — a new departure that avoids the errors normally caused by deflection when the blade is held *horizontally*, as in conventional methods.

The new Norton grinder has many other improved features adding up to greater speed, accuracy and simplicity of operation. And it requires considerably less floor space than do horizontal machines adapted for the same purpose.

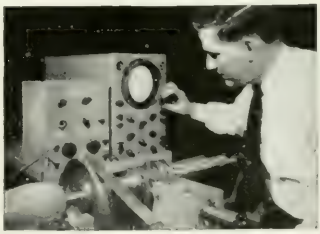
The Broadest Line

The Norton line of grinders and lappers is the most complete offered by any single manufacturer. It runs from small machines for the tool room to high precision, high volume units for heaviest production line duty. Equipped with Norton abrasive wheels these machines form unbeatable combinations for efficient, economical grinding.

To Future Technicians

As the world's largest manufacturers of abrasives and abrasive products, Norton supplies basic tools to all industry. To young men now planning ahead, a career with Norton offers exceptional opportunities for "making better products to make other products better."

Free Booklet describes and illustrates representative types of Norton grinding and lapping machines. Write for your copy.



Guy D. Metcalf, B. S., E. E., Worcester Polytechnic Institute '49, checks smoothness of master cam spindle with specially designed electronic equipment — in connection with his work on Norton cam and contour grinders.

NORTON

TRADE MARK REG. U. S. PAT. OFF.

Making better products to make other products better

ABRASIVES · GRINDING WHEELS · OILSTONES · ABRASIVE PAPER & CLOTH

REFRACTORIES, POROUS MEDIUMS & LABORATORY WARE · NON-SLIP FLOORING

GRINDING & LAPPING MACHINES · BORON CARBIDE PRODUCTS

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

BEHR-MANNING (A DIVISION OF NORTON COMPANY)

ELECTRONICS . . .

(Continued from page 48)

of the particle, or the number of particles.

Very fast and linear circuits had to be developed — circuits which would indicate and record the presence of a particle in a time of the order of one-tenth microsecond. Pulse amplifiers which would amplify pulses of one to ten microseconds duration had to be built. The scintillation crystals are a great improvement over the geiger counter, but without the multiplier phototube and the fast amplifiers, the reaction of the crystals could never be accurately recorded.

Another phase of research now under way in the Physics Department is the work being done by Professor Bardeen on semi-conductors and transistors. The properties of germanium and silicon are being investigated in order that new and better transistors might be developed.

Professor Slichter is conducting research in nuclear magnetic resonance. It is known that nuclei act both as bar magnets and gyroscopes. The magnetic strength of various nuclei, and their interaction with their surroundings, i.e., with electrons and other particles making up matter, is being investigated.

The nucleus, acting as a gyroscope, precesses when torque is applied to its axis, the precession being proportional to the magnetic strength. A typical rate of precession is between 10 and 20 megacycles.

This is detected by placing the nucleus under investigation (for instance, the hydrogen in water in a test tube) in a coil. An alternating voltage is applied to the coil and an alternating magnetic field is set up about the water. When the frequency of this alternating voltage, or alternating magnetic field is equal to the rate of precession, the two are in resonance and the resistance of the coil is found to increase, causing a change in voltage across the coil. This change in voltage is very minute, a fraction of a microvolt, the accurate measurement of which necessitated the development of very accurate and sensitive bridge circuits and meters.

Electricity and electronics, though in itself is not being investigated to any great extent, nevertheless plays an important role in physics research. The Physics Department at the University of Illinois places such importance on electronics that it has equipped and maintains a special electronic work shop in the Physics Building where new designs of electronic equipment are constructed and tested.

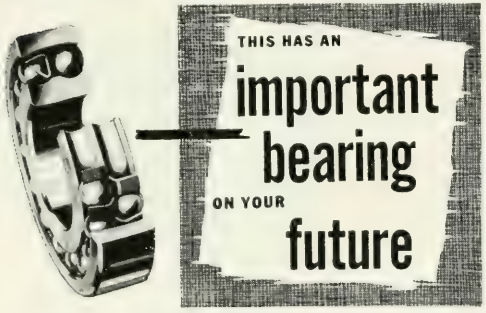
COMPUTER . . .

(Continued from page 20)

input voltage to the 10,300-ohm resistor to drop from 210 volts to 160 volts. The result is that the four voltages are in 50-volt steps, being 204, 154, 104, and 54 volts respectively. The time required to propagate a carry through the 40 stages of the adder is 12 microseconds.

The digit resolver is required to convert the adder voltages back to digital information. The addend and augend come into the adder from the accumulator and the number register, and the sum is returned to the accumulator after passing through the digit resolver. It is the function of the digit resolver to distinguish those sums having the digit 1 left in a stage from those having a zero. The former are the quantities 1 and 3 (having binary representation 01 and 11) while the latter are the quantities 0 and 2 (having binary representation 00 and 10). The digit resolver thus furnishes 0 volts for the accumulator if the adder output is 204 volts or 104 volts and furnishes —40 volts if the adder output is 154 volts or 54 volts.

Due to extreme length this article will be continued in next month's Technograph.



Elimination of wasteful friction is a constant battle confronting Industry. Out on the job . . . irrespective of your engineering role . . . you'll be coming to grips with this problem.

In *the past,* Industry has learned to rely upon SKF for practical solutions to anti-friction bearing problems.

In *the future* — more than ever before — engineers can look to SKF for the finest in bearings, plus help in putting the right bearing in the right place. 7334

SKF INDUSTRIES, INC., Philadelphia 32, Pa. — manufacturers of SKF and HESS-BRIGHT bearings.

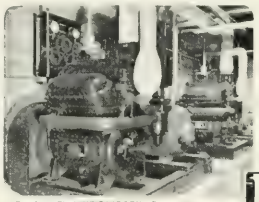
SKF®
BALL AND ROLLER BEARINGS

FRICK *Air Conditioning and Refrigeration Serve Largest Super-market in Middle West*

Bettendorf's new store in St. Louis measures 164 ft. by 160 ft., has 200 employees. Two NEW "ECLIPSE" compressors provide air conditioning, while seven other Frick units cool eleven rooms — for meats, bakery products, vegetables, frozen foods, process work, etc.

Installation by L. V. Fleiter Co., St. Louis Distributors who have put Frick cooling equipment in five other super-markets recently.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.



Frick NEW "ECLIPSE" Compressors at Bettendorf's Super-Market, St. Louis

DEPENDABLE REFRIGERATION SINCE 1883
FRICK CO.
WAYNESBORO, PENNA., U.S.A.
Also Builders of Power Farming and Sawmill Machinery

THIS NEW FLASH POINT TESTING MACHINE is so accurate that a sample with as little as 1/10 of 1% unsafe material in it will cause a rejection. Recently developed by Standard Oil's Engineering Research Department, this revolutionary device reduces the average time from 20 minutes for a flash test to two and a half minutes, avoids human errors in testing flash point, can be used right at the loading rack.

Adventures in Research

The flash point testing problem that was solved with the machine shown above is only one of the many problems presented to Standard Oil's new and growing Engineering Research Department.

In the last few years, it has developed and put into operation instruments to measure vapor pressure, 158° point, acidity and viscosity. Ultrasonic generators have been built for general use in providing energy for experimental purposes. The department is studying application of radioactive isotopes to instrumentation and control problems related to refinery operation.

One of our research divisions is carrying out an extensive theoretical study of stresses in pressure vessels having flat, conical, hemispherical, toriconical or torispherical heads.

In our work on product evaluation, we have developed a new test for quenching oils based on the fundamental heat transfer relationships involved.

Problems such as these are the daily fare of Standard Oil's Engineering Research Department. Here is a challenging opportunity for young men with advanced training in chemistry and engineering. Many and varied problems continually arise in the design, construction and operation of petroleum industry equipment.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

NAVY PIER . . .

(Continued from page 22)

change office. The Dickens office contacts, via an "idle-path" to the Edgewater exchange through "trunk lines."

If an Edgewater line is "available" (clear), the "Switching" frames and "Controlling" frames process the last four digits dialed into the "Originating sender" (Dickens) which relays this information to the "Terminating sender" (Edgewater). The "Terminating sender" contacts a "Terminating Marker" which in turn, connects itself to the "called line" (ED 4-5678). The terminating "Marker" tests "availability" of the "called line."

If the "called line" is clear, the "Terminating Marker," "Terminating Sender," and the "Originating sender" and "Marker" disconnect themselves from the subscribers line and the phone begins to ring. "Call completed." It takes only one thin dime to place in operation complex equipment that is worth millions and it only takes 13-14 seconds.

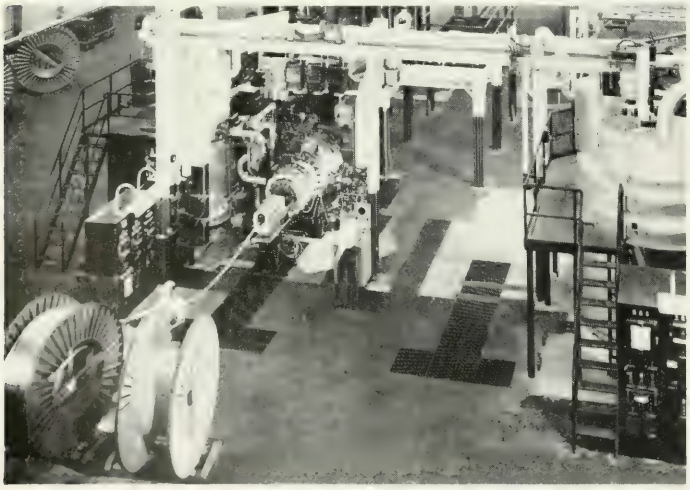
More lies beneath the surface of this explanation. Nothing has been mentioned of all the additional equipment that is required to generate emergency power, signal "break-downs" in the exchange office, the "hee-haw" signal (no such number).

After the tour, visiting students were addressed by executives of Western Electric who stressed the need for electrical and mechanical engineers in their own company. They also invited students to participate in the Western-Electric cooperative Educational Plan, an in-service (plus university) training program.

Technician testing a computer frame with a pre-perforated tape.

Western Electric served a delicious luncheon to the hungry touring engineers before their inspection. An evening program followed. After dinner in the Midwest Engineer's Building in downtown Chicago, the group was addressed by Dr. J. W. McRae, vice-president of the Bell Laboratories, New York. His theme was "The Young Engineer in a Large-Development Organization."

Each student present was "assigned" to a sponsor who was a personage in such companies as General Electric, Westinghouse, Commonwealth Edison, Standard Oil and others. Students and sponsors met before the dinner in an hour of fellowship.



As cable moves down the length of this shop, it is sheathed with Depeth —a polyethylene and a thin outer layer of lead.

MATHEMATICS REQUIREMENTS

According to Dean Frederick Trezise, there is a grave shortage of qualified engineers.

Several projects have been started to alleviate this problem. Engineering alumni are to work through the high schools by counseling students, finding out what people think about the University of Illinois, and by promoting scholarships from organizations.

The mathematics requirements for entrance into the College of Engineering have been raised (as of June, 1953). The college will require high school graduates to have four years of specified mathematics.

CHICAGO'S LONGEST AND SHORTEST

Chicago has engineered the shortest street in the world—Longmeadow.

Longmeadow Street is only 31.6 feet long and has only one side. The other (west side) is all taken up by the intersection of two streets — Lenox and Devon.

The street has only recently appeared in city maps, a direct result of the checking of Howard C. Brodman, superintendent of the bureau.

The one lot on the street has no address because the building faces Devon.

Chicago's longest street is also the longest in the world. It is Western Avenue, which runs for 23.5 miles, and has the longest block in the world, between 111th and 115th, more than half a mile.

You will see that Engineers are somewhat responsible for the contention of non-Chicagoans that there are 48 states AND Chicago, that we have the longest street in the world, the shortest street in the world, the greatest railroad center and yards, the busiest airport, and the largest stockyards. Engineers are, without doubt, responsible for the greatest industrial empire in steel, assembly and manufacturing. Consequently, the Pier Technograph reporters and editors will, from time-to-time, report on engineering developments in this area. We at Navy Pier have a vantage point that contributes richly to our constant education and development. If you have a pet project or interest, if you have a desire for knowledge of buildings, bridges, streets, city planning, assembly and manufacturing processes, research, etc. Just drop us a card. We like to go snooping (engineer-wise) ourselves!

I serve a purpose to this school,
On which no man can frown—
I quietly sit in class,
And keep the average down.
(Nebraska Blue Print)

This is the Boeing team's jet heavyweight

Here is a flight shot of the giant Boeing B-52 Stratofortress. An eight-jet heavy bomber, the Stratofort is a fast, husky teammate to the B-47 Stratojet medium bomber. It's 153 feet long, measures 185 feet from wing-tip to wing-tip, and is powered by eight Pratt & Whitney J-57 engines. Speed and other performance details are carefully guarded secrets.

This Boeing jet-bomber team is another example of the trail-blazing that, for 35 years, has kept Boeing engineers at the head of the design parade.

If you measure up to Boeing standards, you can share this Boeing prestige. You'll work with men renowned in their fields on such challenging projects as guided missiles, nuclear-powered aircraft, and the exploration of supersonic flight.

You can work in Seattle in the Pacific Northwest, or, if you prefer, at Wichita in the Midwest. Boeing provides a generous moving and travel allowance, offers you special training, a salary that grows with you—and a future of almost limitless range.

Plan *now* to build your career as a member of Boeing's distinguished Engineering personnel after graduation. Boeing has present and future openings for experienced and junior engineers in all fields, for aircraft

• DESIGN • RESEARCH
• DEVELOPMENT • PRODUCTION
• TOOLING

also for servo-mechanism and electronics designers and analysts, and for physicists and mathematicians with advanced degrees.

For further information, consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer—Personnel
Boeing Airplane Company, Seattle 14, Washington

BOEING

there's a great future in the 195X Pontiac!

The future of the automobile industry is practically unlimited. More than 60,000,000 cars are expected to be running America's roads by 1975.

The automobile industry has shown almost continual growth—far beyond the most optimistic expectations of the experts of not so many years ago.

And while the industry itself has shown this steady growth, Pontiac has grown even more spectacularly. Today Pontiac holds an enviable position. Its reputation for quality and value and its public acceptance are unsurpassed.

There is, indeed, a future with Pontiac. But more important is this: the most practical way to this great future is by way of designing. The majority of all leading positions in automobile engineering are held by men whose basic training was in designing. It's *one of the best paths* for the young man who wants an engineering career based on opportunity, future advancement and liberal compensation plus General Motors employment benefits.

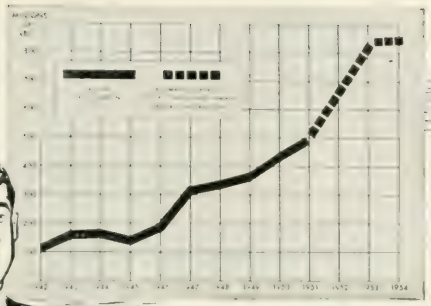
Yes—there *is* a great future for you in the 195X Pontiac.

Pontiac's huge, new engineering building is the industry's most modern with every conceivable facility for designing better and better Pontiacs.

PONTIAC

MOTOR DIVISION • PONTIAC, MICHIGAN

GENERAL MOTORS CORPORATION



Reynolds expanding production —historic chapter in 33 years of continuing growth.

A Fertile Place for Careers to Grow...

Settling tanks, where impurities are separated from sodium aluminate

Tube drawing, one of many mill operations at Reynolds

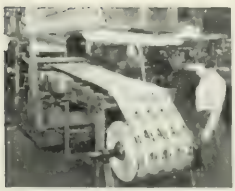
A broad vista of opportunity opens up for college graduates who come to work for Reynolds. The phenomenal rise of the Reynolds Metals Company, known throughout business and industry, is clearly depicted by the above chart. The five-fold expansion in total production of aluminum ingot alone spells broad opportunity. Add to this the vast and productive fabricating facilities of Reynolds —in themselves an enterprise of considerable proportions—and here indeed is a fertile field for any ambitious engineer.

From bauxite mining through metals refining and fabrication to application engineering, sales and marketing, Reynolds offers broad career opportunities. Operating 27 plants in 13 states, and still expanding, there is virtually no limit to what can be accomplished by a capable graduate engineer.

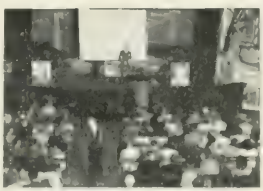
Preliminary orientation in production and sales...direct on-the-job training...liberal insurance, hospitalization and retirement programs...these are all parts of a sound personnel policy maintained at Reynolds.

For important information on "your future in Aluminum," *mail the coupon.* If you are definitely interested now, write direct to General Employment Manager, Reynolds Metals Company, 3rd and Grace Streets, Richmond 19, Va.

REYNOLDS ALUMINUM



Foil—for many uses, including colorful, protective packages and labels; also famous Reynolds Wrap.



Full color movies tell the fascinating story of Reynolds Aluminum. 16mm films available for group showings.

Reynolds Metals Company,
Employment Dept.
Richmond 19, Virginia

Please send me, **FREE,** your 96-page booklet "The ABC's of Aluminum"; also the 44-page book, "Reynolds Aluminum . . . and the Company that makes it."

Name _____

Address _____

School _____ **Class** _____ **Course** _____

SKIMMING . . .

(Continued from page 20)

with metal without getting the "metallic pickup" which might spoil the color, bouquet and, to a certain extent, the flavor of the liquor, were given before installation. Metal tanks can be more easily cleaned than those made of oak, and the same tank can be used successively for holding rye or scotch whiskey, gin, rum, and other spirits. Also, little or no maintenance is required. Advantage over glass-lined containers lies in the fact that metal units will not crack or chip.

While metal tanks have been used before, they have been essentially for transient or blending purposes. Seventy-two hours was usually the maximum time that liquor remained in them. The new tanks are designed to hold the spirits for periods up to six months.

Glowing Cobalt Helps in Construction of Atomic Engine

Twice the world's present supply of radium, which, if obtainable, would cost $130,000,000, would be needed to equal in intensity the rays from a powerful radiation source recently installed at the Knolls Atomic Power Laboratory, which is operated for the AEC by General Electric.

So intense is this radiation that it causes a bluish-white glow in the nine-foot depth of protective water under which the source is kept. The source consists of about 2.5 pounds of a radioactive form of the metal cobalt, known as cobalt 60. The radiations emitted are gamma rays or high-energy X-rays.

The new installation will be used in connection with its work on the design and construction of a full-scale, land-based model of an atomic power plant for U. S. Navy submarines. Physical properties of many materials to be used in constructing such a plant may be altered by the powerful rays generated in the atomic reactor, or "furnace." In this installation such effects may be tested on a small scale.

Common glass, for instance, turns a deep brown when exposed to the rays. The coloration is not permanent, however, as it gradually fades out. Baking at a high temperature will quickly restore the glass to its original clarity.

The glow produced in the water by the cobalt is due to an interaction between the gamma rays and the atoms of which the water is made.

New Instrument Gives Instant Rate of Descent

An electrical-optical "brain" developed by North American Aviation to give instant data on how fast an airplane lands, has recently passed its operational tests. The instrument, Touchdown Rate of Descent Indicator, is knicknamed TRODI. In the past, an experimental airplane's rate of descent was recorded by cameras, but the information was not available for several days. TRODI gives this information immediately, at far less cost. Portable, easy-to-handle, it measures the rate of descent that aircraft structures can withstand with an accuracy of 0.4 feet per second, helps evaluate landing characteristics of airplanes controlled by automatic or manual systems, helps instructors teach student pilots in skillful and safe landings, and aids in determining landing conditions suitable for various aircraft.

A Sound Business

Despite inflation, General Electric is spending some "sound" dollars. The money—a $100,000 order—is for ultrasonic equipment to produce high-frequency sound waves.

The equipment is to be used in the cleaning or degreasing of small machine parts by directing the high-pitched sound waves through a liquid solvent. The sound waves greatly increase the solvent's ability to remove dirt, grease, and metal particles from small corners and crevices, where the solvent alone would be ineffective.

According to the engineers, in the less than eighteen months since high-powered sound waves were first used in industrial cleaning, the field has grown from laboratory research, to a full-fledged, "sound" business.

Isotopic Method Determines Water Content

A method which uses heavy water to determine the total water content of biological tissues and the amount of water of hydration of inorganic crystals and proteins has recently been developed by the National Bureau of Standards. Based on a spectroscopic measurement of the ratio of ordinary to heavy water in a solution containing the sample, the new method is outstanding in the rapidity and convenience with which it can be applied. An entire analysis can be carried out in less than one-half hour. The technique has been applied to include studies of water exchange in resins and of water transport through human capillaries, determination of moisture in the atmosphere, and the identification of unknown organic molecules.

Essentially the NBS technique consists in dissolving a known amount of the material to be analyzed in a mixture of heavy water and ordinary water and then determining spectroscopically the resulting change in the ratio of the two waters. From the difference in this ratio before and after addition of the sample, the water content of the sample material, which is assumed to contain no heavy water, is computed. This method is accurate to 0.5 percent in the determination of water content and is applicable to any material which contains a small, well defined number of labile hydrogen atoms.

Modern Electric Lighting

Modern electric lighting as we know it is only 75 years old, but during that time it has advanced to such a stage that man's day can span the entire 24 hours for whatever he desires to do, be it maximum productive work, study, travel, or recreation. Now we are literally competing with the sun itself.

However, the engineer's work in the lighting field is far from being done, according to Willard C. Brown, manager of the Application Engineering Department of GE.

"People are only beginning to realize their need for far greater quantities of artificial light," Brown said. "The modern light source, remarkable though it is, when measured by the cold yardstick of efficiency—the relation of light output to electric current consumed—is just about the most inefficient device of today."

If every part of electrical energy were changed into "white" light without loss, the result would be 260 lumens per watt, the lighting expert pointed out. In contrast with this theoretical maximum efficiency, the present 100-watt incandescent lamp gives 16.3 lumens per watt of electrical energy used, the photoflood lamp 35 lumens per watt, the mercury lamp 52 lumens per watt, the 40-watt fluorescent lamp 64 lumens per watt, and the eight-foot-long slimline fluorescent lamp 67 lumens per watt.

"However, this is a long way from Mr. Edison's first practical lamp at 1.4 lumens per watt," Brown said. "The modern light source is more than three times as efficient as that of only a quarter-century ago. And lighting and the lighting business, over this same quarter-century, have been increasing at a faster rate than almost any other industry which has been functioning that many years. And today the rate seems to be accelerating.

The trend toward the acceptance of higher and higher light levels can be attributed to greater understanding of the relationship of light and the human seeing machine. "The human eye is a wonderful instrument," he said. "It can see in moonlight, or one-onehundredth of a footcandle. That range is more than a million to one."

Because the eye will see over such

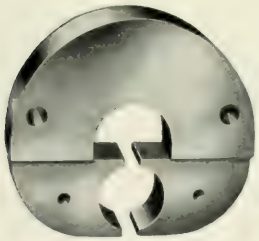
(Continued on page 60)

What's Happening at CRUCIBLE

about permanent alnico magnets

automatic control—permanent magnets are partners in industrial progress

One important part of the "automatic" factory is the requirement that measuring devices be accurate, rugged . . . and because of their use in such great volume they have to be low cost. It is a credit to instrument manufacturers that these meter miracles are being accomplished. Not only are the meters more sensitive, lower cost . . . but specialized problems in measurement are solved everyday with new and different instruments.

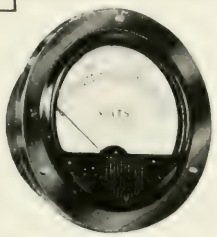


Former design of magnet assembly using Alnico II.

before

Note how redesigned magnet is made lighter because of reductions in area. The change from Alnico II to Alnico V with this design improved flux density.

after



Marion Meter, Model 53RN.

here's how Marion cut magnet costs 1/3 . . . and built a better meter!

Marion Electrical Instrument Company, prominent meter manufacturer, embarked on a plan of redesigning their meters to give improved service. The Marion Meter, Model 53RN shown here, is a good example of what is being accomplished.

In redesigning their instruments, Marion worked closely with Crucible magnet specialists. The recommendation was made to change from Alnico II to Alnico V for the magnetic alloy used in the meter's D'Arsonval movement. Then the magnet itself was redesigned. The overall effect was to reduce the weight of the magnet by 35%, cut the cost ⅓ . . . and increase the gap flux density which resulted in a 15% increase in the torque of the movement. The illustration shows the old and new design.

This development is typical of how Crucible is working to increase measuring efficiency with permanent alnico magnets. Have you a magnet application we can cut costs on by ⅓?

magnet data book available

Since the advent of the alnico market in 1936, Crucible has pioneered in the design and development of special magnet alloys. Send for your copy of Crucible's "PERMANENT MAGNET DESIGN". This booklet points out design factors in the selection of alnico magnets. CRUCIBLE STEEL COMPANY OF AMERICA, Chrysler Building, New York 17, New York.

CRUCIBLE first name in special purpose steels

52 years of Fine steelmaking

Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

SKIMMING . . .

(Continued from page 56)

a tremendous range, the answer to the question, "How much light do we need?" is not easy, according to the GE engineer.

"We know that better lighting improves the visibility of the seeing task. There are good reasons for saying that we should have our lighting arranged so that the more difficult tasks have more light; i.e., so that all tasks have the same visibility." Closely related to the amount of light is the importance of brightness distribution, Brown said. He pointed out that practically all complaints of too much light can be traced to too great brightness contrasts in the visual field. Fixture manufacturers are taking account of this fact in the designs of their luminaries, he said.

Movies in the Dark

A new infrared-sensitive motion picture film which will permit motion pictures to be made in the dark with infrared illumination, or in the semi-dark without, has been announced by the Eastman Kodak Company.

With this film, successful motion pictures were made of audience reactions when house lights in a theater were dimmed to 1 70th of normal room illumination. Known as Kodak Spectroscopic I-N Film, it is intended mainly for use by spectrographic laboratories.

Infinitesimal Leaks in Vacuum Systems

Bothered with a slow leak in your automobile tire? Think nothing of it.

Scientists at the GE Research Laboratory here are worrying about leaks so infinitesimal it would take 10,000 years to empty the contents of a pint bottle.

Dr. Francis J. Norton, a chemist at the lab, said that hydrogen and other gases can seek their way through solid glass and metal at these slow rates. These tiny leaks are sufficient to spoil vacuums used in scientific research.

Recently Dr. Norton found that helium had leaked through the double glass walls housing a vacuum space in a laboratory bottle. Later, when liquid nitrogen was placed in the bottle, the minute quantity of helium caused the nitrogen to boil away. In a similar bottle that was not exposed to helium, the liquid nitrogen remained for a normal length of time without boiling.

Investigations by Dr. Norton have revealed that gases differ in their ability to permeate various barriers. These very small permeation rates were accurately measured by means of an instrument known as the mass spectrometer.

Helium filters easily through glass and plastics, but fails to penetrate metals in any measurable quantities. Hydrogen quickly invades iron, palladium and other metals, as well as glass and plastics. Nitrogen penetrates steel, but is effectively contained by copper. Oxygen slips through silver with comparative ease.

Dr. Norton explained that a gas penetrates through a solid in three easy stages.

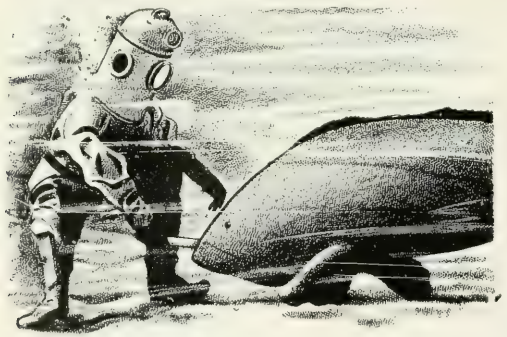
First, gas molecules strike the surface of the solid and form a thin film

Next they migrate into the material over it.

to form a solution inside the solid.

After dodging through the solid's molecules, the gas molecules emerge on the vacuum side of the solid, evaporate and enter the vacuum space.

You've probably heard the one about the lady who had water on the knee. She got rid of it by wearing pumps. And it must have been her father who suffered from water on the brain. One cold night he fell asleep and the water froze. When he awoke, he couldn't remember a thing. Everything had slipped his mind.



The wonders of the ocean's floor are duplicated in two giant tanks at Marine Studios, at Marineland, Fla. More than 30,000 live undersea specimens are presented in their natural setting, and into these tanks are pumped more than 7,000,000 gallons of sea water per day.

Okolite-Okoprene cable was selected as the most reliable means of supplying power to the motors which pump this water. Power is taken from a 2300-volt circuit and stepped down to 220-110 volts, for motors ranging from ¼ to 30 h.p.

The corrosive influence of salt water and salt air has virtually no effect on the tough Okoprene sheath which protects Okolite-Okoprene cable.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE *insulated wires and cables*

8785

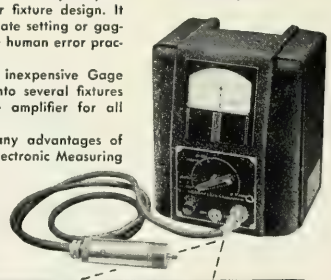
Designed to simplify close-tolerance measurements

Versatile Brown & Sharpe Electronic Measuring Equipment is easily adapted to your machine or fixture design. It provides fast, accurate setting or gagging to .00001" with human error practically eliminated.

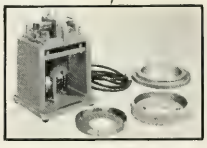
You can design inexpensive Gage Head Cartridges into several fixtures and use the same amplifier for all of them.

Find out the many advantages of Brown & Sharpe Electronic Measuring Equipment. Write for detailed bulletin. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

Gage Head Cartridge and Amplifier.



Gage Head Cartridge mounted on a fixture to measure a fixed gage—used with Amplifier.



Special fixture utilizes Gage Head Cartridge and Amplifier to measure internal angle accuracy to ±1½ seconds.

BROWN & SHARPE

Can you see your future through this Window?

This is an aluminum window, one of four million that will go into buildings in 1953. Twenty years ago, it was just an idea in the mind of an Alcoa development engineer. Ten years ago, only a few thousand were made annually. Now, production *is increasing* at the rate of over half a million a year. This is just one of a torrent of new uses for aluminum which means that Alcoa must continue to expand. Consider the opportunities for you if you choose to grow with us.

What can this mean as a career for you?

This is a production chart . . . shows the millions of pounds of aluminum produced by Alcoa each year between 1935 and 1951. Good men did good work to create this record. You can work with these same men, learn from them and qualify yourself for continually developing opportunities. And that production curve—is still rising, we're still expanding, and opportunities for young men joining us now are almost limitless.

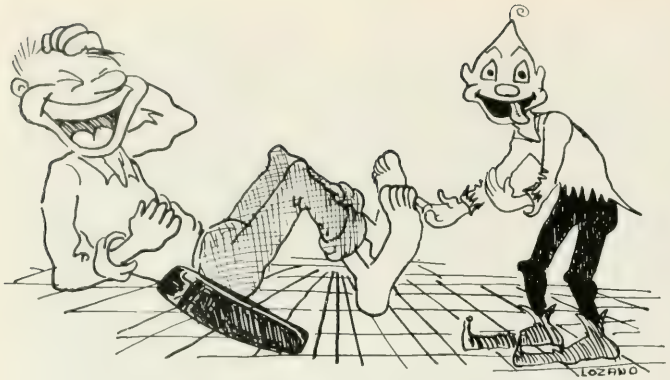
Ever-expanding Alcoa needs engineers, metallurgists, and technically minded "laymen" for production, research and sales positions. If you graduate soon, if you want to be with a dynamic company that's "going places", get in touch with us. Benefits are many, stability is a matter of proud record, *opportunities are unlimited.*

For more facts, consult your Placement Director.

The best things in aluminum come first in

ALCOA ALUMINUM

By ALUMINUM COMPANY OF AMERICA • Pittsburgh, Pennsylvania



TECHNOCRACKS

edited by Maurice Garnholz, A.E., '56, and Bob Mast, M. E., '56

A little girl was entertaining visitors while her mother was out of the room.

"Not very p-r-e-t-t-y," remarked one of the ladies with a significant look.

"No," said the child quickly, "but awfully s-m-a-r-t."

* * *

A clergyman who had been badly beaten on the links by a parishioner thirty years his senior, returned to the clubhouse rather disgusted.

"Cheer up," his opponent said. "Remember, you win at the finish. You'll probably be burying me some day."

"Even then," replied the preacher, "it will be your hole."

* * *

"Going to the ball game?"
"Yeah."
"Go to school here?"
"Yeah."
"Frat man?"
"Yeah, SAE."
"So am I but I don't remember you. Where do you sit at the meetings?"
"Second row."
"Oh, that accounts for it. I'm up in the first balcony."

* * *

Shortly before the invasion started, a general and his staff were watching a troop-carrying glider go by. From it came a carrier pigeon. Powerful field glasses followed the bird to a nearby coop. A colonel raced over, got the message attached to the bird's leg, bounded back breathlessly, and handed it to the general. He opened it with trembling hands, read it, cursed, and threw it on the ground. Then he walked away, his face a bright purple. The colonel waited a moment, then picked up the message. It read: "I have been sent down for being naughty in my cage."

* * *

The chief constable in a small mining town was also an expert veterinary surgeon. One night the telephone bell rang and the constable's wife answered.

"Is Mr. Johnson there?" asked an agitated voice.

"Do you want my husband in his capacity as a veterinary surgeon or as chief constable?" the wife queried.

"Please let's not quibble madam," came the reply. "I can't get my bulldog's mouth open and there's a burglar in it."

* * *

There was a dachshund so long
You haven't any notion
How long it took him to notify
His tail of his emotion.
And so 'twas not uncommon to see
When his eyes were wet with sadness
His tail would still be waggin'
Because of previous gladness.

* * *

A woman was driving her car along an airline highway about 60 miles an hour when she noticed a motorcycle cop on her tail. She pushed the car up to 70 and noticed two cops trailing her. Not to be caught, she upped the speedometer to 80, and at this time there were three cops trying to catch her. Suddenly she spied a gas station. She roared up in front of it and dashed into the ladies' rest room.

Ten minutes later she ventured out through the door and found all three cops waiting for her. Witout batting an eyelash she said coyly, "I'll bet you thought I wouldn't make it!"

I had sworn to be a bachelor,
She had sworn to be a bride,
I guess you know the answer—
She had nature on her side.

* * *

A young, sophomore Daily Illini reporter who was asked to cut his obituaries a little shorter wrote the next day as follows:

"James C. Humphries looked up the shaft of the Urbana-Lincoln Hotel this morning to see if the elevator was on its way down. It was. Age 24."

* * *

Soph: "Did you ever take chloroform?"

Frosh: "No, who teaches it?"

* * *

A hopeful Illini Rural Observer writer submitted a poem entitled "Why Do I Live?" It was returned with a note from the editor, reading, "We regret we cannot use your poem, but we can answer your question. It is because you mailed the poem to us instead of delivering it in person."

* * *

He and his best girl were seated in a corner.

"Give me a kiss," he pleaded.

The girl made no answer.

"Won't you please give me a kiss?" he asked again.

Still no answer.

"Please, please, just one," he begged.

Still no answer.

"Are you deaf?" he shouted at length.

"No," she snapped. "Are you paralyzed?"

* * *

Three athletes from different schools had flunked their classes and were dropped from the team. They got together and talked about their misfortune.

The man from Purdue said, "That calculus was just too much."

The man from Wisconsin said, "It was trigonometry that got me."

The man from Illinois said, "Did youse guys ever hear of long division?"

* * *

He: "If the dean doesn't take back what he said this morning I'm going to leave college.

She: "What did he say?"

He: "He told me to leave college."

* * *

"My boy friend is serving on an island in the Pacific."

"Which one?"

"Alcatraz."

* * *

He: "Will you marry me?"

She: "No, but I'll always admire your good taste."

illinois technograph

.25

January, 1953

How two inches of steel made a yardstick

HERE is one of the busiest machines in our research laboratories. It is a *constant-pressure* test lathe that quickly provides an indication of how fast a steel can be machined.

This unique testing device consists of a standard lathe fitted with special control equipment by which the horizontal pressure on the cutting tool is kept constant during the machining operation. By actually machining a test bar on this lathe and measuring the number of revolutions necessary to advance the cutting tool exactly two inches, we obtain—in a matter of minutes—a precise record of the steel's machinability.

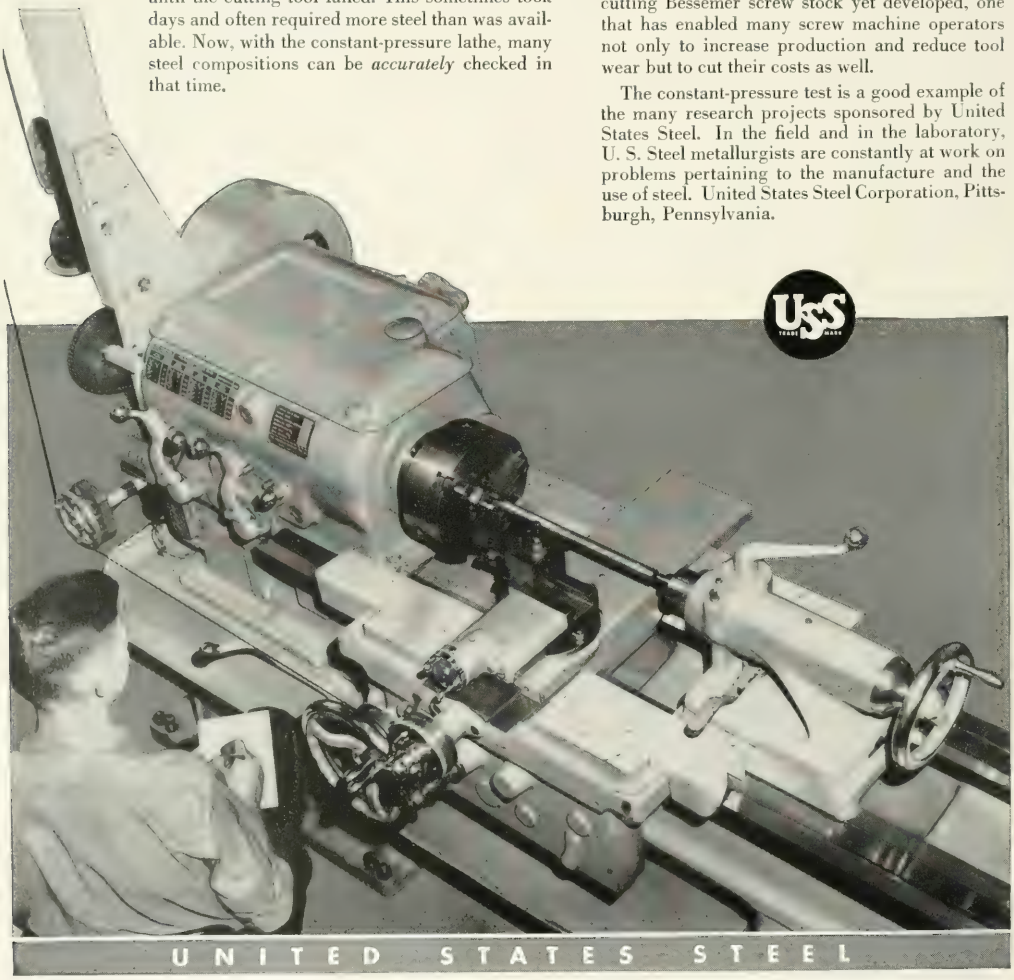
Before this development, the normal way to test machinability was to machine a sample of steel until the cutting tool failed. This sometimes took days and often required more steel than was available. Now, with the constant-pressure lathe, many steel compositions can be *accurately* checked in that time.

Typical of what this has meant to steel users is our development of MX Free-machining Bar Stock.

Bar stock is used in producing the millions of machine parts that are made on screw machines—those high-speed automatic machines that can simultaneously perform many operations such as drilling, forming, threading, chamfering and tapping at a rate of 1000 or more parts per hour. Here, machinability is of first importance, and often spells the difference between profit and loss.

So when we set out to give the screw machine industry steels that would have the utmost in machinability, we called on the constant-pressure test lathe to speed up this research. With its help, hundreds of compositions were quickly and accurately screened. The result was MX—the fastest-cutting Bessemer screw stock yet developed, one that has enabled many screw machine operators not only to increase production and reduce tool wear but to cut their costs as well.

The constant-pressure test is a good example of the many research projects sponsored by United States Steel. In the field and in the laboratory, U. S. Steel metallurgists are constantly at work on problems pertaining to the manufacture and the use of steel. United States Steel Corporation, Pittsburgh, Pennsylvania.



An Editorial . . .

The modern trend in engineering education is toward specialization. As a result of this, many studies in fine arts and literature have been expurgated from the engineering curriculum. Their place has been filled with technical subjects, but a lamentable void has been left in the engineer's education.

He is undoubtedly well versed in the use of the slide rule, the handbook, and the formula; has he ever heard of Nijinski, Ponselle, or Mann? By virtue of his technical skills he is well-fitted to take his place in industry; what skills has he acquired to enable him to take a place in society?

He has been deprived of an extremely valuable part of his education, the study of fine arts and literature. The personal satisfaction so easily derived from an appreciation of art, music, and literature; the diversity of interests, the wide variety of conversational topics; and, so necessary to advancement in the business and social world, the ability to get along with persons of all types; all of these have been snatched from the engineer in the mad rush for technical training.

This situation could be readily remedied. Through a judicious choice of subjects, a truly liberal education could be gained without the expenditure of an excessive amount of time. A few hours spent in the study of "Music Appreciation," "Great Literature of the World," and "Ethics, Logic, and Psychology" would open doors to new fields of interest to the student; doors that were formerly not only locked, but of which the student was unaware.

The courses required in such a program would probably not be courses that are being taught at the present, but would have to be arranged so as to fulfill the goals of the new curriculum. These goals would be: the fostering of a true appreciation of different art forms such as music, through the building of a foundation which, with the student's further experience, would lead to this appreciation; and the understanding of basic human psychology and ethics.

The hours spent in such a course of study would be repaid many times, in many ways. The intrinsic worth of the benefits to be derived from this curriculum cannot be readily evaluated, the wider range of interests, the increased conversational adeptness so easily acquired with the foundation of a well rounded education; are hard to assign a definite value. The most benefit that the student would get from this course of study would be the personal satisfaction and enjoyment that could be derived from a sincere appreciation of the fine arts and literature. New horizons of enjoyment and unlimited possibilities of recreation would be opened to him.

RICHARD L. SYDNOR

to the

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or

PHYSICIST

with an interest in

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or

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volume 68 number 4

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our cover

Today's metallurgists are working overtime to develop new alloys to meet the demands of increased speeds, temperatures and pressures found in the machines and vehicles of the atomic age. The cover shows a workman pouring a test specimen for tensile and metallurgical tests against a background of a 100X photomicrograph of the crystalline structure of grey cast iron. Photomicrographs such as the one shown are useful in analyzing metals and alloys. (Photomicrograph courtesy U. of I. Metallurgical Engineering Laboratory).

our frontispiece

A giant power shovel removes the overburden from a central Illinois strip mine. In mining operations, a large number of specialized machines are used such as the power shovel, the continuous miner and the conveyor. Many of these machines have been developed in recent years making the age-old mining industry as modern as today's progressive mining engineers' accomplishments. (Photo courtesy Illinois State Geological Survey)

MARION
LITTLE SISTER COAL CORPORATION
MARION
5561

faster coal mining by the . . .

Joy Continuous Miner

by Paul E. LaViolette, E. E. '56

On December 14, 1948, the Joy Manufacturing Company came out with another one of its many "firsts" in coal mining — the first practical single-operation coal mining machine capable of being commercially produced.

The Joy Continuous Miner, as it was named, does in one quick operation what has been formerly an expensive, time-consuming, and dangerous process. Instead of drilling, cutting, and blasting, the J.C.M. unit literally rips coal loose from the seam face at the rate of 130 tons per shift. The mined coal, washed down and in manageable chunks, is then carried on internal conveyors to the rear of the machine to be loaded onto mobile conveyer units.

The Joy Continuous Miner is the result of eight years' intensive research by the engineers of the Joy Company. They have not been alone, however, for every mining machinery maker has been working on one. Bituminous Coal Research, Inc., allocated $250,000 for the development of a similar mining and loading machine. Several companies were able to make models, but were unable to work out production difficulties. Today there are more than one hundred fifty Joy Continuous Miners in operation with more on order.

The machine comes in two heights: thirty-four inches for low seam mining and forty-five for high seam. It is slightly more than twenty-five feet long by seven and one half feet wide. The J.C.M. is composed of three parts: (1) a ripper bar unit consisting of a rotary drum type head fitted with carbide bits and dampening hoses; (2) main chassis with controls, power and intermediate conveyer; and (3) a rear conveyer unit. The ripper bar unit is fitted with a rotary drum head, an innovation which is far superior to the older type side cutters. It needs less power and bits and is capable of a larger percentage of chunk size over one inch. The ripping itself is basically as follows: the machine is advanced to the coal face and the ripper bar lowered to the base of the seam. Here it is advanced eighteen inches horizontally into the coal by hydraulic pressure. This advance in the coal seam is known as "sumping." The ripper bar is then forced up through the coal seam by hydraulic pressure. The rotary drum action rips the carbide teeth free of the coal seam bringing with them large chunks of the coal to be conveyed to the central hopper. Other teeth replace the ones removed and the ripper bar is forced to the top of the seam. On reaching the top, the bar is again lowered, the machine crawls forward the eighteen inches gained, and the process is repeated.

All coal that falls down from the head in front of the unit is scooped up in a chute directly behind the ripper bar unit. This, too, is hydraulically raised and lowered.

The whole ripper bar unit can be trained in an arc of forty-five degrees. This enables the continuous miner to turn from a twelve foot mine entry into a twelve foot room at ninety degree angle. The bar can also be depressed five and one half inches below the base and elevated sixty-six inches above it; allowing full maneuverability in following the seam especially when there are noticeable bottom rolls.

All power motors are assembled on the main chassis. Power is supplied to the rotary drum on the ripper head unit by two sixty-five continuous horsepower motors giving to the unit a total of one hundred thirty horsepower available at all times. Hydraulic pressure is maintained by a fifteen-gallon per minute gear pump driven by a seven and one-half horsepower motor. All electrical equipment is kept to a minimum and all of it is explosion proof. The power supply is remote; connected to the continuous miner by a cable connected to the rear of the main chassis.

The operator controls are on the right hand side of the main chassis, fourteen feet from the ripper head thus allowing the operator to remain under

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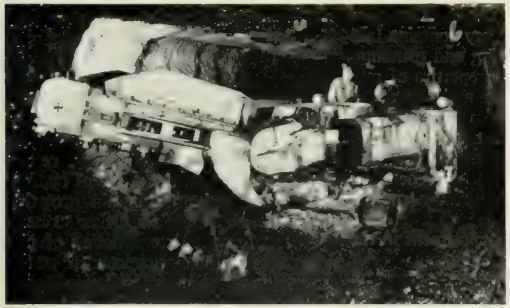
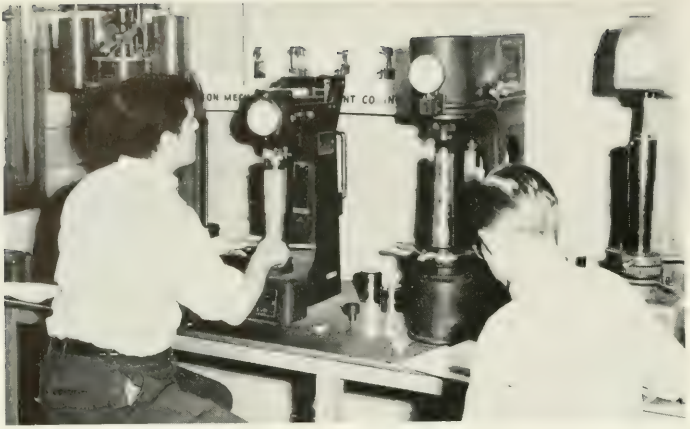


Left: Working a "room" with the continuous miner. Operator, well clear of cutting head, controls machine operation with levers. Right: A low seam Joy Continuous Miner ideally suited for working seams of 40 to 60 inches thickness, about to "sump" a pillar. (Courtesy of Joy Manufacturing Company.)



Testing hardness of metals by measuring the depth to which an indentation is pressed into the surface.

The Technograph features the . . .

The material foundations of our modern society depend, to a large extent, on a continuous supply of large quantities of minerals and metals. An organization which does much to insure that this ample supply will continue is the Mining and Metallurgical Engineering department here at Illinois. Although the fields of mining and metallurgy are both centuries old, the rapid developments in these fields during the last two decades have put the fields of mining and metallurgy a t the frontiers of engineering. These frontiers are being explored and new areas are being discovered here at Illinois.

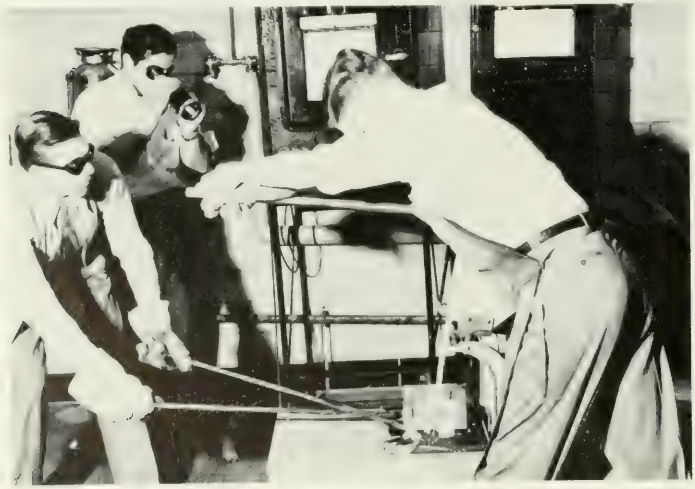
The teaching and research activities of the mining and metallurgical engineering department are conducted mainly in the metallurgical engineering laboratory, the mining engineering laboratory, and the ceramics building. The Met lab houses the metallographic, electro-metallurgical, and heat treat laboratories. It also has laboratories for the study of physical and mechanical testing, fuels, and furnaces. The mining engineering laboratory contains labs for the study of sampling and grinding, chemical and physical properties of materials, coal preparation and ore dressing, and ventilation. In the ceramics building are the departmental offices, x-ray diffraction units, mine models, a museum, a design room, classrooms, a departmental file room, and a mining instrument room.

No description of a department in the college of engineering is complete without some mention of research, which is such a vital function of engineering. The department does research in three areas of mining. In the field of mine ventilation, electrical and anemometric gauges for the measurement of the flow of air in closed ducts have been developed. Research has also been done in the field of explosives, with the blasting effects of commercial explosives being investigated to determine the useful energy formed under controlled conditions. Research has also been done on physical properties of m i n e r a l s and rocks. Hardness, strength, and various elastic properties have been investigated.

In the field of metallurgy, research has been done on the effect of hydrogen in welds, and on subgrain growth in cold-worked metals. Other research projects are the determination of phase diagrams by the electropotential method, the determination of radiation damage in metals, and the study of a special phase, occuring in various binary and ternary alloys, called the sigma phase. Finally, work is being done in investigating the internal friction in metals.

The history of the mining and metallurgical engineering department dates back to the beginnings of the University of Illinois. The initial report of the Committee on Course of Study and Faculty provided for courses in mechanical science and art, civil engineering, mining engineering and metallurgy, and architecture. . . . In spite of these early plans, mining engineering education was slow in catching on. Up to 1885, the department never had more than six students in any one year, and the total number of graduates since 1867 was six. The curriculum in mining engineering was discontinued in 1889. It started up in 1891, but was discontinued again in 1893.

In 1907, W. F. M. Goss was appointed Dean of the College of Engi-



Casting an experimental alloy while the temperature by an optical pyrometer.

Mining and Metallurgical Engineering Department

by Bob Schrader, Chem. E. '54

neering. Dean Goss was eager to have the department of mining engineering reestablished. The new department was started in the fall of 1909, with Harry Harkness Stark, then editor of the technical magazine, *Mines and Minerals*, appointed head of the department. Professor Stark continued as head of the department until his sudden death in 1923. Professor H. L. Walker, present head of the department, has said of Stark, "Dr. Stark's vision, enthusiasm, and technical ability were responsible for the development of the curriculum, the construction and equipment of a fine mining laboratory, the securing of a competent teaching staff, and the maintenance of the highest standards of technical instruction."

Until the fall of 1912, the offices and classrooms of the Mining Department were scattered all over campus. That fall the mining department moved into the second floor of the then new Transportation building. Departmental and staff offices, class rooms, drafting rooms, and the museum were housed in the transportation building until 1941, when the department moved to its present location in the ceramics building. Also, the newly constructed mining laboratory was occupied in the fall of 1912.

An option in metallurgy was first offered in 1916. The metallurgical option was elected in the senior year and consisted of courses in process metallurgy, mineral dressing, and metallurgical design. This option was continued until 1934, when a curriculum in metallurgical engineering was offered. By 1935, the name of the department had been officially changed to the department of mining and metallurgical engineering, and the first degree in metallurgy achieved its full prominence in 1937, when the metallurgy lab was completed. This laboratory consisted of an east addition to the mining laboratory.

Metallurgy is divided into three main divisions: chemical, physical and mechanical metallurgy. Chemical metallurgy is concerned with methods used to produce and refine metals from their ores. The chemical metallurgist attempts to design methods for more efficiently winning metals from their ores, to get rid of impurities in the ore, to develop refining techniques, to study the rate and mechanism of reactions at high temperature, to develop better refactory materials, and to improve general production procedures.

Physical metallurgy deals with the nature, structure, and physical and mechanical properties of metals and alloys. The physical metallurgist studies the nature and internal structure of metals and alloys, their chemical, physical, and mechanical properties, their heat treatment, and the methods of testing, commercial uses, defects, and design of new alloys for special purposes.

Mechanical metallurgy includes all the processes of working and shaping metals, such as rolling, forging, spinning, and casting. The mechanical properties of metals and alloys produced by the forming operations and with the proper design of equipment for accomplishing these tasks. In the foundry he is concerned with the effects of all variables of design of alloy composition, temperature of metal, molds and molding, and other techniques.

Obviously, a four year curriculum in metallurgy cannot hope to give the student a knowledge of all the diversified fields of metallurgy. The curriculum does attempt to equip the student with a firm foundation in metallurgical principles so that he can enter any industry, and to give him a sufficient

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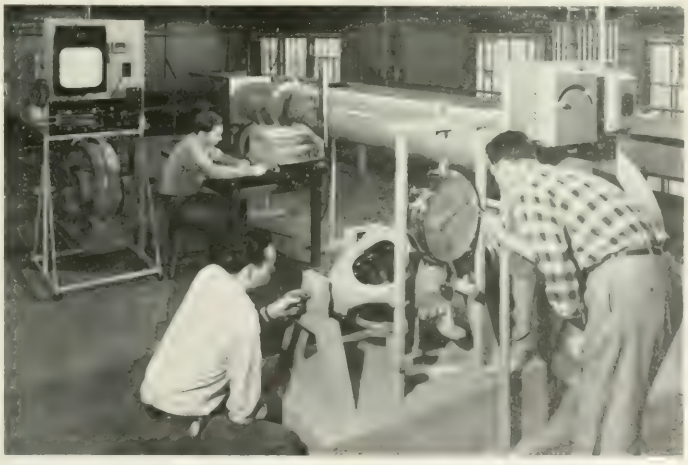

Students in mining engineering conduct an experiment on a centrifugal fan in the Ventilation Laboratory at the University of Illinois.

the Technograph tours the . . .

WHITE PINE PROJECT

by Warren H. Brandt, C. E. '54

The highest place in the State of Michigan is Government Peak in the Upper Peninsula — 2,003 feet above sea level, but the busiest place by far is within shouting distance of this prominence and that is the White Pine Copper Company's White Pine project; located in Ontonagon County, about 18 miles southwest of Ontonagon. Remarkable changes have been wrought in the stands of second growth timber that dot the foothills of the beautiful Porcupine Mountains.

The terrific wartime demand for copper has resulted in one of the greatest exploration and recovery programs to be instituted in recent years. The demand for copper is probably only exceeded by the demand for steel. As a result many old abandoned copper workings have been re-explored, and those which were formerly unprofitable have been investigated in the new light of present needs. And such is the case of the White Pine project.

Historically, Ontonagon County and copper have been intimately united since Ontonagon's first citizen—Jim Paul—recovered the fabulous copper boulder bearing his name on the banks of the Ontonagon River near the present site of the Victoria dam, in 1776. The monstrous boulder which Paul found was supposed to have weighed in excess of five tons, but its present weight at the Smithsonian Institute is three tons. The news of this boulder spread like wildfire especially after it was put on exhibition in Detroit.

Mining commenced in the Ontonagon country after the turn of the nineteenth century, but the larger developments did not get under way until 1847 when the famed Minnesota mine opened. This mine was noted for the huge dividends which were declared on its stock as a result of the high quality of the ore recovered. Work at the present site of the White Pine Mine did not get under way until 1881 when a 170 foot shaft was put down together with several other minor workings, all founded in copper bearing rock. Because of the low grade ore recovered work was discontinued in the following year.

In the early 1900's the Calumet and Hecla Copper Company became interested in the dormant White Pine property and purchased it. By means of a series of diamond drill exploratory tests they determined the extent of the workable ore body and undertook means of recovering it. Their operations were rather successful and they erected several stamp mills, crushers and associated equipment on the slopes of the Mineral River near the site of the original White Pine shaft. These workings are in ruins at the present time, but they attest the value of the original property and ore body, a portion of which is under development now.

The author, Warren H. Brandt (left), assists Bruce Graham on a computation in the White Pine field office of PACE Associates. (Photo by Edwin Urpila)

The C & H Company closed down operations at White Pine in 1921 and most of the physical plant was removed. This was the second time that the White Pine area went into a temporary seclusion due to a lack of interest in the low grade ore body.

The Copper Range Company of Boston, Massachusetts, became interested in the property in 1937. It has put down a pilot shaft — the Bill Schacht shaft, to determine the character of the main ore body, the type of recovery methods to be used, tools necessary for ore recovery and any additional information pertinent to the efficient operation of the property.

This shaft, which slopes at an angle of 30° to the horizontal and is 570 feet deep, will be a part of the main workings after present construction in the area is completed. The shaft will connect with a new shaft now being driven at right angles to it.

On the basis of the Copper Range Company's explorations it has been conclusively determined that the ore body now being tapped is of sufficient magnitude to furnish copper for the next fifty years. Some have termed it the largest body of undeveloped copper ore on the North American continent.

The ore body being worked is in the main a chalcocite, cuprous sulfide (Cu_2S) containing about 80% copper. In addition there is a small amount of native copper in the form of copper flakes of almost infintestimal size. The chalcocite with the native copper brings about 6% copper to the ton of material removed. This relatively light recovery is balanced by the extensiveness of the ore body.

On the basis of these preliminary studies the Copper Range Company was granted by the U. S. Government's Reconstruction Finance Corporation the largest peacetime loan ever made — 57 million dollars — to construct the necessary facilities to recover, process and ship the metallic copper from the White Pine site.

The Copper Range Company thereupon set up as a separate entity to operate the property, the White Pine Copper Company. The White Pine Copper Company hired the well-known Turner Construction Company as it's agent for the construction job.

The Copper Company had determined that to efficiently recover the ore, ultimately 1200 employees would be required. Immediately prospectuses were prepared to secure the necessary architectural and engineering skill for the design of a town and associated works to house these employees. Also needed were plans for the process buildings and required connective facilities such as administration buildings, garages, etc.

Selected for this monumental task was the six year old firm of PACE Associates, Chicago. PACE (stands for planners, architects, consulting engineers) was well qualified to handle this assignment on the basis of its architectural

and engineering treatment of a similar venture for the Reserve Mining Company at Beaver Bay, Minnesota.

The site planning department of PACE set about at once to lay out the streets and homes for the White Pine Copper Company employees. PACE has in its employ a sociologist to guide the site planners in the layout so that the neighborhood ills so common to the older American towns and cities would be avoided in the pioneering effort of White Pine. The curved street layout, the judicious treatment of parking and shopping centers, exhibits dramatically the sociological viewpoint of keeping these important items in the forefront of intelligent planning and design. With beautifully landscaped residential areas, well designed stores and schools, the White Pine town should be a model for all future city planners to point to with pride.

The original surveys for the White Pine townsite were under way in March, 1952. Required was a complete topographic map of an area about two and one-half miles square. This region is heavily wooded and swampy, making any kind of survey work difficult. Nevertheless the surveys proceeded and as soon as the first topographic sheets were available the architects together with the city planners prepared drawings for the first buildings in the townsite. These are a hospital, four dormitories, a boiler house, service building housing the cafeteria and a staff dormitory. These buildings were commenced in May, 1952, and are practically complete.

As soon as surveys were available in the White Pine works area architectural plans were prepared for the important buildings to be used for processing the ore and for related services. PACE Associates have prepared plans and supervised the construction of a works administration building, a warehouse and machine shop and a mine change house. The other process buildings are under design by another engineering firm to take advantage of their familiarity with the chemical and metallurgical processes of treating copper ore.

In the late summer of 1952 plans for a school and a shopping center were being prepared, rounding out the entire White Pine townsite with as many facilities benefitting the community as possible.

The entire White Pine mining arrangement is unique in that a minimum of handling of the copper bearing rock is required. The initial processing of the ore will be done underground. In contrast to the usual methods of transporting the rock from the mine to the smelter, that of using small cars and an elevator in a shaft, the White Pine mine will use conveyor belts. These belts will carry the ore directly from the working face to the process area underground. The initial crushing is carried out in a plant near the present pilot shaft. As mentioned before, all this work is done underground with the gangue, or waste rock, being returned to the mine for disposal subsurface.

Donald Heikkinen, PACE Associates instrument man, sets his transit up over a survey station in the White Pine townsite. The signal on the left is for sighting from distant stations.

At present a huge portal is under excavation adjacent to the works area. This portal leads on a gentle slope into the pilot shaft and will utilize the pilot shaft as an integral part of the mining operations. This tremendous excavation is 250 feet wide and 1000 feet long. It grades from ground level at the works area end to a depth of eighty feet at the pilot shaft end. The crushing plant will be located in this portal slope and will subsequently be covered with earth. Excavating the portal requires some of the largest earth-moving equipment ever to see the Upper Peninsula and was pursued throughout the summer months on a twenty-four hour a day schedule.

Considerable quantities of water are required for processing the copper ore. Originally plans called for the construction of a dam on the Iron River, one and one-half miles distant from the works area. This plan was abandoned when it was determined that the volume of water in the river in some of the dry summer months might not be sufficient to operate the plant. It was decided then to construct a water tunnel into Lake Superior six miles north of the White Pine townsite. The intake is to be located about 2000 feet out in the Lake where potable water is available. The expense of constructing this tunnel will be more than offset by the wealth of geological information secured in driving through the underlying rock formations.

All buildings in the works area are of reinforced concrete construction or steel and brick construction for permanence. They are of course as modern as the far-seeing architect can make them.

In addition to the works area and the townsite there is a trailer camp which will house families utilizing that means of dwelling. It is completely modern, having full water and sewage facilities together with a service building for each block of trailers to provide the necessary accommodations for bathing, washing clothes, etc. The presence of this trailer area has attracted many persons who like that means of commuting and has enhanced the position of the trailer in the travel and transport world.

The townsite is of course, the most important area as far as the worker is concerned and no expense has been spared to make the surroundings as comfortable as possible. The engineers have laid out most of the ten miles of curved and winding roadways and some of the 940 dwelling units. The streets are to be a hard surface with curb and gutter. They are mostly on gentle grades giving the visitor an impression of being in a rather hilly region. Actually the townsite is located on a narrow plateau between two river valleys —the Mineral and the Iron. While the townsite is not free to expand in an east-west direction it has unlimited room for expansion in a southerly direction and this feature was important in the selection of the particular site used. The dwellings likewise are located

(Continued on page 14)

introducing . . .

by Roger L. Funk, E. E. '56 and Robert H. Hardin, E. E. '54

PROFESSOR H. L. WALKER

A large majority of the top educators on the University campus are men who have had exceptional backgrounds both in industry and in education. No exception to this is Professor H. L. Walker, head of the Department of Mining and Metallurgy.

Professor Walker received his Bachelor's degree from Michigan College of Mining and Technology in 1932; his Master's in 1933; and a professional degree in 1935.

His broad experience in industry includes work as laboratory technician, research engineer, and Assistant to the Superintendent at Munising (Michigan) Paper Company; engineer for a Southern Illinois coal industry; and consultant for various metallurgical industries. During the war he was with Technical and Industrial Intelligence, and traveled to Germany, Austria, and Czechoslovakia to obtain and evaluate research on enemy industries. He was

PROFESSOR H. L. WALKER

interim Director of Mines and Minerals for the State of Illinois in 1947, and again in 1949. During the past year, he was Governor Stevenson's personal representative to investigate the West Frankfort coal mine explosion.

His experience in education began in 1932 when he was made instructor of Metallurgy Engineering at Michigan College of Mining and Technology. He held this position until 1937 when he went to Washington State College as Assistant Professor of Metallurgy and Metallography. He has been at the University of Illinois since 1938 as Assistant Professor, Associate Professor, and Professor in the Department of Mining and Metallurgy. He was made Acting Head of the Department in 1940; he has been Head of the Department since 1942.

Professor Walker's membership in eleven professional organizations is evidence of his active interest in the development and progress of his profession. He is chairman of the Peoria Chapter of the American Society for Metals; he has been a member of the executive board for the past ten years. A very active member of the American Institute of Mining and Metallurgical Engineers, he is chairman of the committee on graduate studies, and a member of the committee on student relations; program committee, and executive committee on mineral industries resarch. He was a member of he executive board of the Illinois Mining Institute from 1943 to 1945. Other organizations of which he is an active member include the American Association for the Advancement of Science, the National Society for Professional Engineers, Illinois Society for Engineers, Illinois State Academy of Science, and the American Society for Engineering Education.

Professor Walker is national President of Alpha Sigma Mu, metallurgy honorary, and a member of Sigma Xi, research honorary, and Tau Nu Tau, military fraternity.

He likes to spend his vacations on Lake Superior and in upper Michigan, where he spends his time fishing, hunting, loafing, visiting with old friends, and doing some work on a hobby of his, photography.

But speaking of hobbies, Professor Walker says his first love is his dogs. One, "Walker's Deluxe Jake," is an American Pointer. The other, "Walker's Deluxe Duke," is a Brittany Spaniel. Both are trained hunting dogs, and almost any day, in season, of course, you'll find Professor Walker and his two dogs, "Walker's Deluxe Jake" and "Walker's Deluxe Duke," roaming the countryside hunting pheasants and quail.

RICHARD SLOANE

Richard Sloan, one of our fine seniors, began his career in engineering as a pre-engineering student at Murray State Teachers College, Murray, Kentucky. He attended school there for two years, and then transferred to the University of Illinois. Here he is majoring in Mining Engineering.

Dick was born in West Frankfort, Illinois, and went to the Frankfort Community High School. He played

RICHARD SLOANE

basketball all four years of high school and football three years. One year he played football with a broken rib. In his senior year he was the Student Body President. He was awarded the Peabody Coal Scholarship.

"Face South Sloan," as his Triangle Fraternity Brothers call him, is five feet, eleven and a half inches tall, has a car, and is single. Among his hobbies are model jet racing cars, golfing, and "rifle bumming."

Richard is the president of the Mineral Industry Society, and is a Student Associate of American Institute of Mining and Metallurgical Engineers. He is a member of the Rifle Club and was the Pledge President of the Triangle Fraternity.

For the past three summers Dick has worked for the Peabody Coal Company. Last summer he did underground surveying at their Danville mine, the Oakwood Coal Company. Just recently Richard completed the oxygen breathing apparatus course of the Bureau of Mines and is now working for his first aid certificate.

As are the other seniors at this time, Richard is faced with the problem of what he will do after graduation. As of now he is planning to work for the Peabody Coal Company as a mining engineer, that is with Uncle Sam permitting.

OPPORTUNITY IN MINING

by George B. Clark, Assoc. Prof. of Min. Eng.

It is a sad fact, but nevertheless a true one, that very few of the engineering students on the campus, let alone the student body as a whole, realize that there is a curriculum in mining engineering at the University of Illinois. For the information of the readers of *Technograph*, I'd like to give a few facts concerning not only mining engineering education on the University of Illinois campus, but about the profession of mining engineering as well.

As with other groups of engineering taught at the University of Illinois, our minin engineering is recognized as being among the best there is. We are well equipped, too, with laboratories in fuel analysis, mineral dressing and coal preparation. Our mine ventilation laboratory is one of the most modern in the country, both with respect to equipment and instrumentation. One of the features of the laboratory is a new type average velocity gauge which was recently developed in the mining department. The mining curriculum is a broad one and provides the student with a well rounded engineering education as well as specialized study in mining.

The salaries for graduating mining engineers are right at the top, but in spite of this the enrollment in mining engineering has dropped (country wide) in the past two years much more, in proportion, than most of the other branches of engineering. The reason for this has not been ascertained.

Perhaps it is because of the fact that mining does not have the apparent glamour that other branches of engineering do. Or, perhaps it is because mining is considered erroneously to be an overly dangerous occupation. Whatever the reason, the number of freshmen enrolled in mining last year was about 200 for the whole United States.

This means that the demand for mining engineers during the next few years is going to be much greater, in proportion, than in other types of engineering. Right now there are three times as many jobs as there are mining engineers to fill them. And since the requirements of the mining industry for technical men is going to increase with the increasing demand for minerals and the increasing difficulty of finding and mining them, the demand for trained men will continue to grow.

Of course, it must be recognized that mining is among the hazardous occupations, but this should offer the young engineer more incentive to help solve the difficult safety problems of the mining industry. From a scientific point of view many mining problems are more difficult of solution than those in electricity, mechanics, etc., because of the many variables involved. Hence, it is a most fertile field for research and graduate study.

There are many branches of the mining profession which are open to engineers. Two of these, safety engineering and research, have already been mentioned. In addition there are the fields of mine operation, engineering design, mine administration, mine ventilation, engineering sales and teaching. Each offers an opportunity for development according to the desires and capability of the particular person concerned. The choice of location and living conditions is very extensive, including foreign service. A survey of the mining profession has shown that there are at least 30 different types of jobs which the mining profession offers, directly in mining and in closely allied industries.

A student might, among many similar questions, ask himself:

1. Do I, in addition to my ability to solve problems in mathematics, physics, chemistry, etc., like to work with the "forces of nature" inside and outside of the laboratory More specifically, do the problems involved in learning of the forces which exist in rocks around mine openings create an interest in my mind?

2. Am I interested in the saving of human lives — lives which are needlessly given every day to produce the basic minerals we need to maintain our high standard of living

Shearing a coal seam in an Illinois mine with a coal cutter. Machines such as that illustrated have been developed as a result of extensive research in mining. (Photo courtesy of U. of I. Mining Dpt.)

3. Am I interested in academic work, teaching and research, in a new and fertile field in which there are only a score of men in the country at present who hold Ph.D. degrees?

4. Do I think I would like to work with and or supervise the men who produce our coal, gold, silver, etc., from beneath the earth's surface

If a young prospective engineer can answer any of the above questions in the affirmative it would be well for him to further investigate the possibilities of the mining profession as a career.

by Ray Andrews, '56 and Charles LaRobadier, M. E. '55

CONFUSED KIDS

Poor little Junior, mixed-up little kid that he is, doesn't know which world to live in. Television is the evil that has forced this unsuspecting innocent into the great realms of despair and frustration that he is in today. From Space Cadet to Hop-A-Long Cassidy, the young child waivers back and forth, not knowing just which terminology to use. The complexity of this problem of the youth of today cannot be stressed too much. It can only be appreciated by actual contact with these victims of circumstances.

"Great Galloping Galaxies!" a little lad cries as he jumps from his saw horse pony. He's after Marshall Scott fer asendin' him to the interplanetary pen for a five-year stretch. Git Marshall Scott on the two-way wrist radio afor it's too late!"

"Contact! Contact!" shouts his playmate. "Hello, is that you Randolph? Just got word by pony express that Two Ray Gun Pete is acomin' to git ya!"

"Leaping rings of Saturn," comments the calm, cool, and collected Marshall. "I must take a double dose of my quick energy capsules and round up a posse to relentlessly track down this man."

Meanwhile, in a different part of the playground, Two Ray Gun and his right-hand man, Uugra, are talking—

"This sure is a rough ride, but it's worth it to git even with that no good Marshall," says villanous Two Ray. "I've sure been awaitin' fer this here chance to git him. Many's the night I paced my space cell, just awondering how I was agoin' to do it."

"Say, Boss," quips Ulgra, "how ya agoin' to do it? By the paralyzing ray, real slow, or even slower by staking him out in the desert sands to let him doe of thirst(evil laugh)."

"I thought that I might leave him in the Martian tidal zone and let him drown in the finter floods. Or I could—"

"Jumpin' horse flies! Look to the north!" yells Ulgra. "Indians ariding their vicious one-man rockets!"

"Faster! Faster!" shouts Two Ray to the driver.

But it isn't fast enough. Recess is over.

With apologies to William:

To sleep or not to sleep: that is the question:
Whether 'tis easier in body to suffer
The endless morning hours of somniferous study,
Or to rationalize, and in so doing,
Mitigate the constant plaguing of our consciences
That warns we should not, must not sleep? Ah, to sleep;
And by this wondrous, yet evasive sleep
Is ended all the countless tribulations
That seem to endlessly harass those
Who must, but somehow cannot, learn to study.
Oh, wise was he who called this sleep "a blessed thing"
But knew he full how difficult its winning?
To sleep; but then we dream: aye, there's the rub;
For in that peace which from our guiding consciences,
Was won by sheer fallacious reasoning,
We dream not of good life and lovely maidens,
But of our slide rules we have yet to slide
And of the stress and strain we have not calculated.
Then, perchance, is this the cause
That forces us to bear this vast intinity
Of work and all of its entailments,
Professors' dislike and eccentricities,
Both personal and geometrical,
Daily quizzes, hour exams and finals,
The aforesaid nights of irksome somnolence,
All of which contribute to a feeling which
Unfortunately, has no claim of panacea?
Or is it from the dread of making
Fiascos, rather than successes of our futures?
But regardless of our diverse motives,
We labor in this sea of struggle,
Perhaps, ourselves quite ignorant
Of why we persevere and strive,
Except to hold the name of scholar.

* * *

Dissertation on a Slide Rule:

Have you ever analyzed that leather-cased instrument that hangs from your belt? Well, let's examine it for a minute.

Innocent looking thing that it is, it's really not so. First of all, it's a calculating little gadget that has a nasty habit of persistently sticking out its tongue. It delights in becoming unmanageable, especially during exams. Only at such times does it reveal a need for lubrication or adjustment. Then it demands bold-facedly, with an irritating sticking, to be powdered like a newborn babe and threatens the use of its cursor if one isn't swift about doing so. It likes to be hanging from a belt loop when it's being hunted under a chaotic pile of books on a desk.

But really it isn't so awfully bad. It stays with us—when we have it hooked to ourselves, it works for us although it's only when we push it and it gets results—like two times two is equal to three point nine, nine, nine eight.

And who can deny that, in spite of himself, he becomes attached to his slip stick, if only by a snap and loop?

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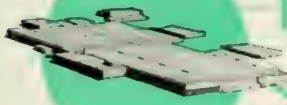

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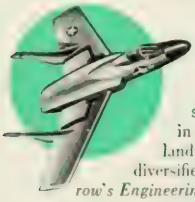
Security restrictions prevent a full discussion of the guided missile projects at Chance Vought, but growing requirements in all phases of development and production are creating new demands for all types of engineers and scientists. These missiles are in production for intensive experimental uses and presently are being flight tested with excellent results.



For thirty-five years Chance Vought's position in the aircraft industry has been one of pioneering and leadership. One of the latest achievements is the tailless swept wing F7U-3 "Cutlass" now in full scale production. This twin jet fighter, in the "more than 650 miles per hour category," is designed to operate from both land bases and aircraft carriers. For further information about Chance Vought and its diversified opportunities in engineering, consult a copy of our publication titled "*Tomorrow's Engineering*" now on file in your college placement library. If you are receiving a degree in Engineering, Mathematics or Physics, contact your Placement Director for an appointment with the Chance Vought Aircraft representative who will visit your campus soon.

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part two . . .

Illinois Digital Computer

edited by Hank Kalapaca, E. Ph. '53 and Ken Kolence, Physics '53

The following is the second and concluding part of an article on the Illinois Digital Computer. It involves a detailed analysis of input-output, memory, control, and power supplies, much of which was derived from a technical paper by Professors R. E. Meagher and J. P. Nash, both with the University of Illinois.

Input-Output

The input equipment consists of a photoelectric tape reader which is able to "read" the punch-coded teletypewriter tape at a rate of two feet (220 lines of punched code) per second. This is 40 times as fas as a teletypewriter operates. The input is by means of a standard 5-hole Teletype tape of which four holes are used to represent numbers in the sexadecimal or base-16 number system by means of a binary code. A 40-digit binary number is then written as a 10-digit sexadecimal number.

Output from the machine can be either to a tape punch which operates at 5 times standard teletype speed or to a teletypewriter. In either case it is in the sexadecimal system, although if it is desired the output can be programmed and converted by means of a simple routine to decimal quantities.

Memory

The memory is of the electrostatic "Williams" type using 40 *3KP1* cathode-ray tubes. Each cathode-ray tube stores 1,024 binary digits and can receive binary information from one digit of the accumulator and can release its stored information to the corresponding digit of the arithmetic, number, or order registers. Thus the total storage is 1,024 words of 40 binary digits. A slave cathode-ray tube and a 40-position switch are provided so that the contents of any one of the operating tubes can be viewed at one time. The cathode-ray tubes are operated with their deflection plates and second anodes at about 150 volts positive with respect to ground and with their cathodes at about 1,900 volts negative with respect to ground, giving an accelerating potential of about 2,050 volts.

Each cathode-ray tube is mounted in a horizontal position with its own shield consisting of a layer of copper, a layer of mu metal, and then a second layer of copper and a second layer of mu metal. Each cathode-ray tube is provided with an adjustment for intensity, focus, and astigmatism.

Associated with each memory tube is a chassis which contains a 4-tube "video" amplifier with a gain of about 50,000 for a 1.5-microsecond pulse. The chassis also contains the logical circuit to provide for regeneration in the usual way and for transfers of information to and from the appropriate registers. The output of this chassis is capacitively coupled and then d-c restored to the grid of the cathode-ray tube. The "2-dot" system of storage is used where the sensing position of the beam is called the dot and the other position is called the "dash." The beam is on for about 1.2 microseconds in the "dot" position and about 2.5 microseconds in the "dash" position. The period between cycles of memory operations has commonly been set at 22 microseconds, although all of the useful operations, including the clearing and gating of information, require about 16 microseconds.

The voltages for the deflection plates of the cathode-ray tubes which specify the position of the beam for each of the 1,024 memory addresses are obtained from an "address generator" which converts ten binary digits into 32 vertical positions and 32 horizontal positions by adding the currents from five binary stages for each. Some special care has been taken to insure that the deflection voltages are free from noise by providing special regulation for two of the voltages and by suitable limiting of the voltages on the wires which carry the ten binary digits to the "address generator."

Control

As has been mentioned the control of the Illinois machine is direct coupled and asynchronous. Rather than have an external timing device for signalling each of the operations it is to perform, it operates by having each of its operations signal the one to follow. The speed with which it operates is therefore determined by its own ability to carry out the sequencing operations which are required. Since it is direct coupled the machine will simply stop if no signal is supplied for an operation. On the other hand, the machine can be made to stop by deliberately inhibiting a signal.

(*Continued on page 20*)

Doctor James E. Robertson stands at the control panel of the Illinois computer while Gene Leichner feeds the data into the input mechanism. (All photographs and diagrams courtesy of the Digital Computer Laboratory.)

Using an electron tube developed by RCA, automotive engineers have perfected an instrument which automatically controls automobile headlights.

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(*Continued from page 18*)

Let us consider one flip-flop F and two operations A and B.

When F is in the 0 state, A occurs and causes F to turn to 1. This initiates B which returns F to 0, and the sequence is repeated. Thus one flip-flop can be used to sequence a pair of operations. In the same way, n flip-flops can be used to sequence 2^n operations.

There are obvious defects in the simple example just cited. In the first place, the signal from A may turn F to 1 before A has had a chance to do its work. If this happens, the enabling signal to A will disappear and A will never be completed. Secondly, B may take place while A is still on. This could have disastrous results if the two signals were related, as, for example, when A clears a register and B gates information to that register. If B gates while A is still on and, worse still, if B never gets really turned on, the information would never be gated.

In order to prevent failures of these kinds, safety circuits have been designed into the Illinois machine control. These circuits do the following things:

1. They make the turnover requirements for control flip-flops more stringent than the turnover requirements for the flip-flops being controlled. Therefore, if the latter do not turn, neither will the former, and the machine will stop.

2. They require that when a control flip-flop is being turned over and sensed, the signal from it be used only when it has been positively turned.

3. They require that before an operation in a sequence can occur the previous operation must not only have taken place but that it must also have been turned off.

Examples of circuits of these kinds may be found in the shift sequencing control. Shifting in the Illinois machine requires four operations, two clears and two gates, and these are sequenced with two flip-flops. Let us take a look at one of these flip-flops, the one which is turned over by a register gate bus. But first let us recall the register gating.

When the cathode of the gate tube is pulled down from +10 volts to −10 volts the contents of the second flip-flop will transfer if the grid was positive. Flip-flop grids are either 0 volts or negative about −20 volts. Since the cutoff of the *6J6* used for gating is about −4 volts, the gate will start to conduct when the cathode is at about +4 volts, and the transfer will have occurred by the time the cathode gets to 0 volts.

The same gate bus which pulled down the gate cathodes in the register is used to turn the control flip-flop F (Figure 4). But now the gate tube G is pegged at −5 volts instead of at 0 volts. This gives a 5-volt safety margin in the turnover of F, and it can be safely assumed that the register flip-flops turned over if F did.

Negative signals are used in nearly all of the Illinois machine control. Before F was turned, pin 6 was negative. After it is turned by G, pin 5 is negative, and one might be tempted to take the signal for the next operation from here. But this would be a mistake, for pin 5 might go far enough negative to initiate the next operation before F is

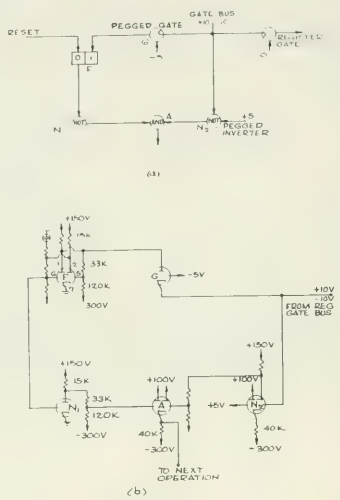


Fig. 4

safely and permanently turned over. Therefore the signal will be taken from the positive-going grid 6 which is the last moving element of F. It will be sensed with the inverter N_1 which is built just like F. Because of the cutoff properties of N_1 it will not conduct until the grid gets up to −4 volts, and by then we know that F is safely over. The output of N_1 therefore says that the register gate bus has gone down and that F has been turned over. The turnover of F will shut off the gates in the register.

We still need to know that the gate bus is back up again before proceeding with the next step. This information is obtained from the inverter N_2. With pin 5 pegged at +5 volts, the signal from N_2 will not be negative until the gate bus is safely off again. The outputs of N_1 and N_2 then go to the "and" circuit A which starts the next operation when its cathode goes negative.

This is the kind of philosophy which has prevailed in the design of the control. Throughout the control an effort has been made to assure the safe operation of each step. If any step should fail, the result is not a loss of the information in the register but merely a "hanging up" of the machine. The control waits until the proper enabling signal comes along, and then it proceeds. This kind of construction makes it possible to test the operation step by step by putting switches in appropriate places so that the turnover of flip-flops can be controlled. One such place is in the cathode of the gate turning over the flip-flop F in the previous example. If this switch is open, the register gate will not turn off and the machine will wait until the switch is closed.

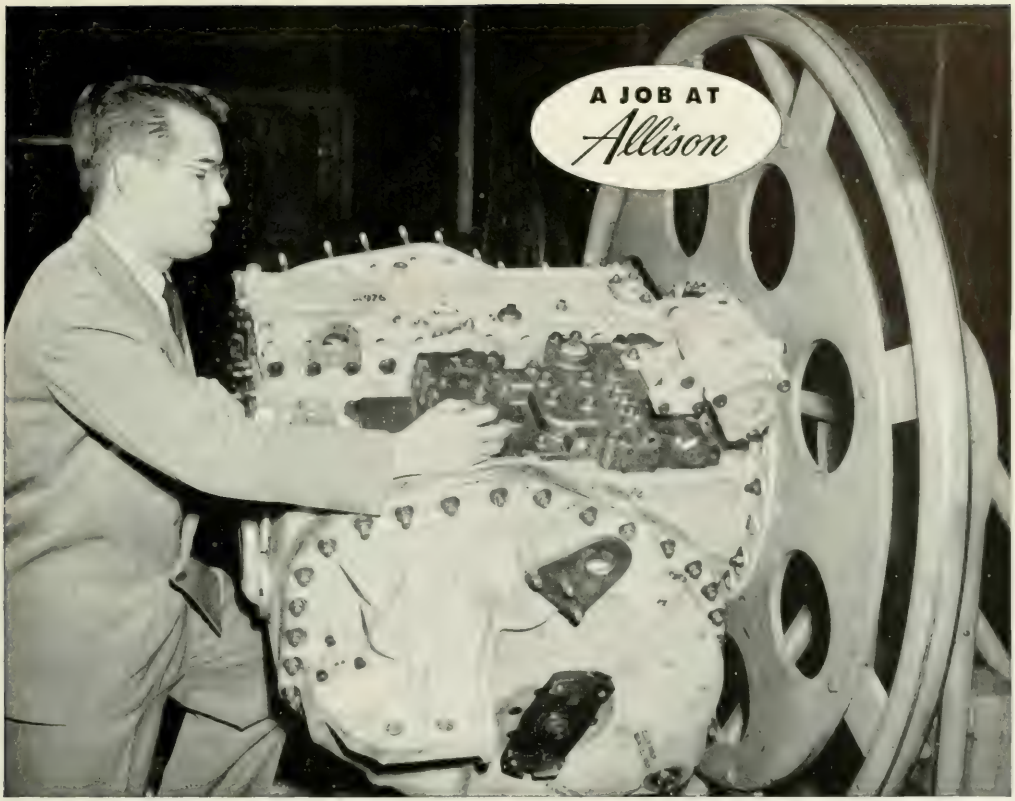
A price must be paid for these safety features, and the price, of course, is speed. The machine will run faster if it is not necessary to wait for checks on the operation. It will also run faster if operations are done as much as possible in parallel. Here again, although the Illinois machine is a parallel machine, a price has been paid in speed for convenience in doing certain control operations sequentially rather than in parallel.

The Illinois machine memory is synchronous with a period of 22 microseconds. When the control is carrying out operations which do not involve the memory, it works independently while the memory regenerates its storage locations. But if an operation requires use of the memory, the control and memory must be synchronized for one 22-microsecond interval, called an action cycle. In order to get into synchronization the control furnishes a signal to the memory. Since this signal may occur at any time during the 22-microsecond cycle, the control must then wait for an appropriate memory pulse, the action sense pulse, to come along. When this pulse comes, the action cycle normally takes place. During this cycle information is transferred to or from the memory, the necessary clearing and gating operations for these transfers being executed more or less directly by the memory pulses themselves. This one case where the memory clears and gates in the registers is the only synchronous control operation in the machine.

The action cycle ends when the next action sense pulse occurs 22 microseconds after the one which began the cycle. At this time a "have used memory" signal goes to the control to indicate that the use of the memory has been completed. The memory returns to regenerating, and the control resumes its asynchronous activity.

The synchronization process requires two flip-flops. One distinguishes between an action cycle and a regeneration cycle. The second distinguishes

(*Continued on page 36*)



● Robert F. Karcher, a 1951 Mechanical Engineering graduate from Purdue University, is another Allison engineer who is pioneering in an advanced field of mechanics. He is playing an important role in the Research and Development group of the Transmission Engineering Section.

Allison is the world's largest manufacturer of torqmatic drives for heavy-duty Ordnance and commercial vehicles and equipment. These transmissions serve a purpose far broader than a unit in the power train. All the steering and braking of the vehicle also are accomplished in the transmission. These operations are controlled by hydraulic circuits which consist of clutches, pumps, governors and necessary valving to make them operate in the proper sequence. The assembly of the valving system is often termed the "brain box" of the transmission since it determines how the transmission will operate to provide maximum performance and maneuverability with finger-tip control.

Bob, shown above examining a CD-500 transmission, is involved in developing a new improved system of governing automatic control systems of many Ordnance and commercial transmissions. This involves basic analysis, design and testing of pilot samples. These hydraulic controls provide proper sequence for clutch operation to determine speed range, convertor or lock-up operation. They also provide steering control for the vehicle when this function is included in the transmission.

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non-credit course in . . .

MINE RESCUE AND FIRST-AID

by Richard L. Sloan, Min. E. 54

The Mine Rescue and First-Aid courses are non-credit courses for anyone interested. To be eligible to wear an apparatus during a rescue operation, a physical examination must be passed. For those who do not pass the physical, they are permitted to assist in the operation from a fresh air station or from the surface.

Some of the requirements of the physical examination are as follows: (1) The applicant must have a 20/30 or better vision in each eye; (2) he must have solid front teeth, including all bicuspids. No removable bridges or plates; (3) a pulse rate is taken for a full minute while the applicant is standing and another is taken two minutes after completion of a step exercise. If the first pulse rate is exceeded by *two* beats per minute, the applicant is not considered physically fit to wear the apparatus. The course is offered from 6 o'clock to 10 o'clock one night a week for 5 weeks.

Three years ago, through the initiative of Professor R. G. Wuerker of the Mining Department, the United States Bureau of Mines of Vincennes, Indiana, furnished the first non-credit rescue course at the University of Illinois. (Two years previous to this time, a similar course was offered in the summer time for credit. Due to it being a summer course, there was little interest shown and the course was dropped from the curriculum.)

During the next two years, the State of Illinois Department of Mines and Minerals offered the course under the instruction of William J. Williams, Superintendent of the Mine Rescue Station in Springfield, with the assistance of J. J. Kotzman, Inspector at Large from Staunton, and C. S. Tartar, Superintendent of the Benld Mine Rescue Station.

The students taking the course this fall were the first group ever to be trained with the new Chemox Oxygen Breathing Apparatus. The apparatus is a self-contained breathing circuit operating independently of the outside air, employing a replaceable canister containing a chemical which, upon contact with the moisture in the exhaled breath, evolves a plentiful supply of oxygen for breathing requirements and absorbs the exhaled carbon dioxide moisture. The Chemox apparatus is equipped with an automatic timing device which rings a bell at the end of a pre-set time interval to indicate that the wearer should return to fresh air. This apparatus is illustrated by the first two men on the left of the second row in the apparatus picture.

The McCaa apparatus has been the standard apparatus used by mine rescue teams. This apparatus is being worn by the first four men from the left on the bottom row of the apparatus picture. The instruction for this apparatus covers the different tests for tightness and tests for the working parts. Also, practice in wearing the apparatus is required. The apparatus carries a steel cylinder charged with 135 atmospheres of oxygen. The carbon dioxide is removed from the exhaled breath by Cardoxide, a highly efficient absorbent that performs this function with a minimum of heat generation. A pressure gauge is the timing device employed in the McCaa apparatus. The wearer can check to see if he has enough oxygen to continue his advancement or if he has to return to the fresh air station. Operation and care of the machine is practised throughout the course of Mine Rescue.

An apparatus not much used for mine rescue work anymore is the One-Hour Oxygen Breathing Apparatus. It works on the same principle as the McCaa apparatus but the oxygen lasts but half as long due to the capacity of the oxygen bottle and its smaller construction. It can be used in low coal seams where the McCaa would be too cumbersome. The student learns only the operation of this machine and not much time is spent on its working parts due to its similarity to the McCaa machine. This apparatus is illustrated by the third and fourth men from the left on the second row.

The Gas Mask is an apparatus that

(*Continued on page 32*)

Students of the first aid and mine rescue course. Top (from left to right) E. E. Neihaus, W. H. Stoewer, S. B. Gafvert, Philip Urso, J. J. Yancik, J. J. Kotzman, State Mine Inspector-at-Large, L. Felts, Research Assistant, University of Illinois. Center (from left to right) J. P. Snider, D. Trainor, W. H. Donley, P. A. Holtorf, O. Terichow, W. J. Williams, Superintendent of Mine Rescue Station, Instructor of the course. Bottom (from left to right) R. G. Wuerker, Assistant Professor, University of Illinois, H. Ramiros, J. Romero, R. L. Sloan, R. E. Clemons.

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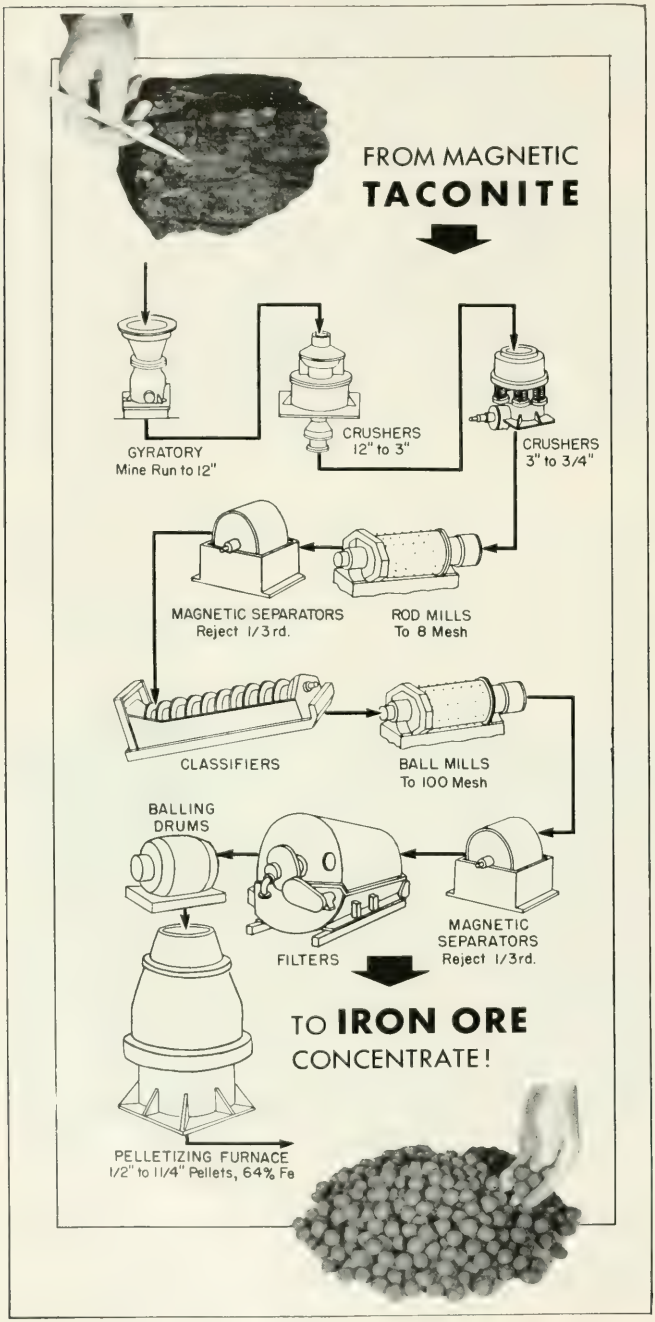


TACON

INTRODUCTION

Taconite, a word not found in most dictionaries, is a hard rock containing 25 to 35 per cent iron. Taconite deposits are now getting serious consideration because the higher grade ores left in Minnesota, Michigan, and Wisconsin are being depleted rapidly. There are bellions of tons of this rock lying on the Mesabi range in northeastern Minnesota. This area, which extends 110 miles in l engtli and varies from one to three miles in width, produces over one half of the nation's iron ore. Here the greatest activity has been directed toward the concentration of the magnetic taconites. Data for future taconite plant operation is now being furnished by large pilot-plants which produce tailor-made agglomerated iron ore from the taconite rock. The reduction of the iron-bearing rock, to a form of high grade iron ore, which took nature geologic ages to accomplish, will be done in these plants through continuous process. The use of these deposits of low grade ore permits the conservation of the high grade ore so necessary in times of national emergency.

The taconite program now developed on the Mesabi Range includes five major stages: exploration, research, mining, separation, and cementing together, or agglomeration, of the powder-fine iron minerals.

I. EXPLORATION

Exploration for taconite is as much an engineering problem as mining th etaconite after it is found. Such exploration is done by drilling and is of utmost importance in the successful development of a property, as it furnishes the basis for all subsequent operations. Efficiency in exploration concerns every step in the o peration from the time a property is first considered as an exploring possibility until the last estimate is made or the property abandoned.

Prospect or exploration holes are drilled to prove out the extent and structure of known deposits of the taconite rock. The earlier exploration on the Mesabi Range was by means of trenches, test pits, and shafts. However, as the necessity for deeper and more rapid exploration arose, diamond and churn drills were brought into use. The diamond core drill, which is used

by **EDWIN HUMPAL, M.E. '53,** ***Wisconsin Engineer***

E on the MESABI

for the hard taconite formations, penetrates rocks for a rotative cutting action producing a core for inspection and analysis. The prospect churn drill, which is used for surface drift and soft formations, penetrates rocks by percussive rather than by rotative action. A continuous flow of water, forced through hollow steel drills, flushes out drill cuttings which are delivered to settling tanks, andthen collected and analyzed.

In diamond drilling a string of hollow rods made in standard ten foot lengths, is rotated by the drill engine through a shaft and gearing. At the bottom of the line of rods is the bit, an angular ring of steel or sintered carbide in which are set the carbons of "black diamonds" which do the actual cutting. The core produced is forced into the lower rod, known as the core barrel, and is held there by a core shell and spring. When the rods are pulled up, the core and cuttings combined from a five-foot run make up the usual sample. Sampling is one of the most important steps in exploration, since it reveals the character of the formation under consideration.

II. RESEARCH

While exploration is proving out the presence and extent of the taconite deposits, research is experimenting with the material. Methods for concentration and agglomeration are developed in the research laboratory. The most feasible and economical of these methods are then tested in pilot plants. The taconite program on the Mesabi is now in the pilot plant stage. These pilot plants produce a factory-made iron ore from the hard taconite rock.

The University of Minnesota and the various mining companies are now carrying on research to find the best method to factory-make ore. The Oliver Iron Mining Division, U. S. Steel Company, is spending more than $23,000,000 to find out how to factory-make ore at costs competitive with the ores from other domestic and foreign sources. Oliver's development work on taconite starts in the iron ore research laboratory located in Duluth and continues in the pilot plants on the Mesabi Range.

Work was started at the University of Minnesota by Dr. E. W. Davis in 1945 on finding a satisfactory method to agglomerate the taconite powder by a pelletizing process. Three years later, he had enough pellets to test in an experimental blast furnace. It is his method which is used today to produce pellets from taconite concentrates.

III. MINING

The first problem to be considered in the mining of taconite is the "stripping off" of worthless dirt and rock before the iron bearing rock is exposed for drilling and blasting. An advantage of the taconite rock over high grade ore is that it lies much closer to the surface, thus decreasing stripping costs. After the overburden is carried away, blasting is necessary to break up the taconite into chunks which can be loaded by the six to eight cubic yard power shovels used in the open pit mines.

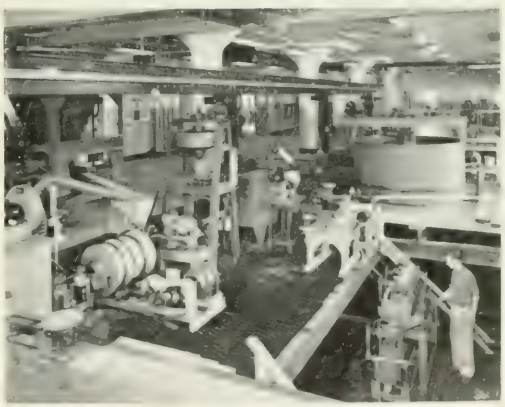
The major problem involving the mining of taconite is that of finding the most economical method of drilling primary blast holes. In these holes are placed explosive charges taconite is one of the hardest rocks on the continent, it which break up the original mass of taconite. Because requires better drilling and blasting equipment than high grade ore. Three methods of drilling the taconite are now being tested.

The oldest method used for drilling taconite is churn drilling. Unlike that of the prospect churn drill, the cutting tool is made of solid steel and is not hollow. The drill cuttings are not flushed out with water, but instead are bailed out after each few feet of drilling. The blasthole churn drill can drill holes up to nine inches in diameter by striking sharp, heavy blows with drill tools weighing more than a ton and traveling 40 inches or more per stroke. These machines are propelled by electric, gasoline, or Diesel power.

The two newer methods of drilling taconite are accomplished through the use of the Ingersoll Rand Percussion Type Air Drill and the Linde Air Products Jet Piercing Machine. In the "jet piercing" machine, kerosene and oxygen are mixed to produce an intense heat of 4500 degrees, which burns a hole through the very hardest of taconite and iron formation.

After the taconite is drilled and blasted, electric shovels, taking up to 12 tons in one bite, load it into diesel loco-

(*Continued on page 26*)



Laboratory at Duluth, Minnesota, requiring millions of dollars to manufacture millions of tons of usable iron ore.

TACONITE . . .

(*Continued from page 25*)

motives or diesel powered trucks. Conveyors belts may also be used to carry the taconite to rail loading stations on the surface. The physical characteristics of the pit usually determine which method of haulage will be most economical. The best method is then used to haul the taconite to a concentration plant.

IV. SEPARATION

Because of the low iron content in taconite, complete pulverization is necessary to gain access to the iron. This is accomplished by crushing and grinding.

The "jet piercing" machine symbolizes the spectacular experimentation found in iron mining operations. Kerosene and oxygen are mixed to produce an intense heat of about 4500 degrees. This burns a hole through the very hardest of taconite and iron formation. Powerful explosives are then inserted for blasting.

The magnetic taconite from the open pits is first brought to the gyratory crusher, where it is crushed from pit run to 12 inch chnuks. It then passes through two more crushers and enters the rod mills as material sized about ¾ inch. The rod mill crushes the orfe to a minus 8 mesh and passes into a magnetic separator. Here the magnetic ore is mixed with water and circulated through an open topped trough under a slowly moving rubber belt. Iron particles are pulled from the trough by a magnet and carried to the classifier where soluble material is carried away by water jets. The remaining ore is then routed through the ball mill where steel balls grind it to a fine powder of minus 100 mest. After it is routed to a second magnetic separator and a filter it is then ready for agglomeration. Because the fine iron oxide cannot be used or shipped economically unless it is in the form of lumbs or clinkers, several processes have been developed for agglomerating the fine powdery concentrate.

The Oliver Iron Mining Division, U. S. Steel Company, is also working with non-magnetic taconite which involves a somewhat costlier and more involved separation process. Instead of using magnets to get the iron out, it is done by "flotation." The character and nature of the mineral surface is the all-important factor which affects the flotation process. The process is essentially a chemical one and depends on the tendency of certain minerals to be selectively filmed by various chemicals and oils. The adoption of the flotation method has been held back not by the cost or lack of effectiveness of flotation separation methods, but by the lack of a cheap and effective method of pelletizing or sintering such material. With the development of such processes the flotation of non-magnetic taconites, will soon find a place in the concentration of the Mesabi Range taconites.

V. AGGLOMERATION

The agglomeration step is one of the most difficult in the taconite program because the product must retain its properties under all kinds of weather conditions, including rain, freezing, and thawing in the year round operation of taconite plants. It must be strong to withstand the severe handling on its way to the furnaces and it must have desirable physical properties in order to make furnace operation economical.

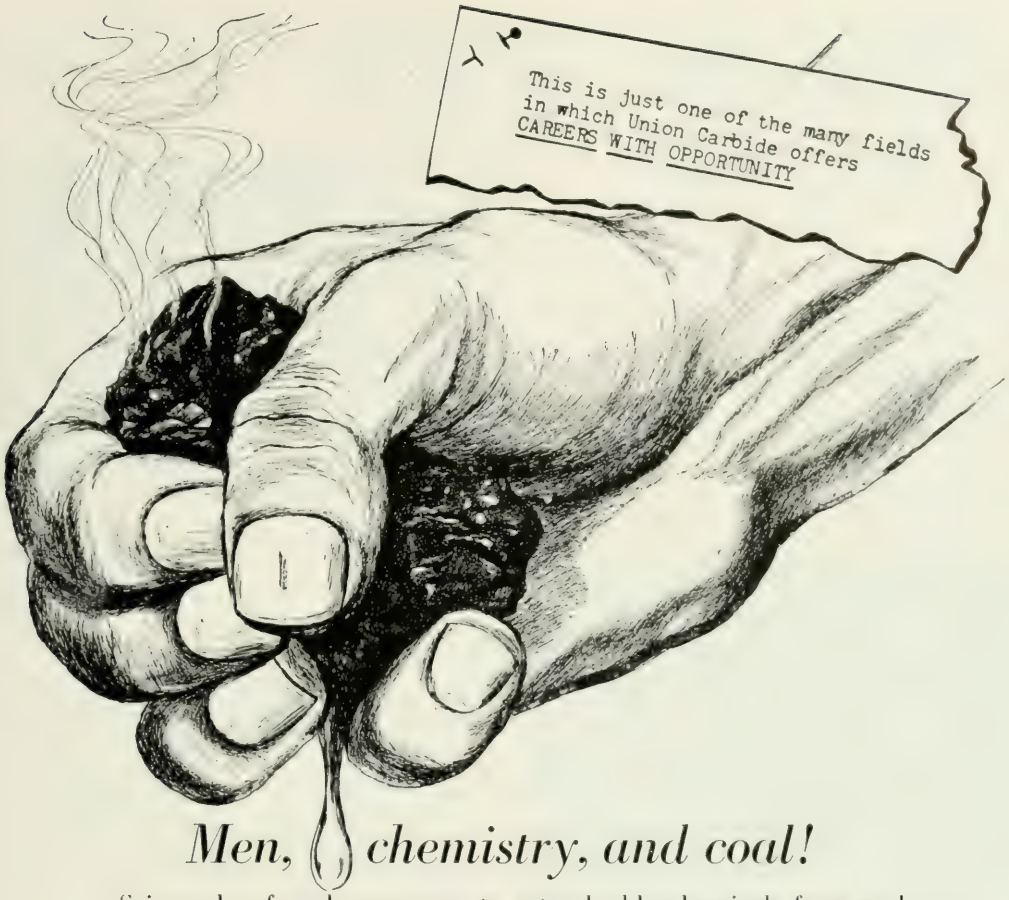
The agglomeration plant at Virginia, Minnesota, is the first experimental combination sintering and nodulizing pilot plant on the Mesabi. It has the capacity to produce approximately 500,000 tons of taconite concentrate per year. Of the three main buildings, the largest, which houses the sintering machine and the raw material section, is five stories high, 400 feet long and 60 feet wide.

During the breaking-in period, and until iron ore concentrates are available from the experimental taconite milling plant at Mountain Iron, fines from the Rochleau mine are being used in the Virginia plant. Various methods of agglomerating have been developed, such as pelletizing, briquetting, nodulizing, and sintering, but it is not yet known which one will be the most economical and make the best product for the furnaces. This plant will experiment with only two of the methods used for agglomeration in an effort to develop a method which may become part of a permanent commercial taconite plant.

In the operation of the pilot plant, fines are separated from the coarser material by a vibration screen and then carried by a conveyor to ten 750-ton capacity storage bins at the nodulizing and sintering plant. The fines, taken from the storage bins to either the sintering machine or nodulizing kiln are agglomerated into larger sized material for blast furnace use.

The sintering machine is six feet wide and 96 feet long. The fines are mixed with coke in pug mills and the material

(*Continued on page 28*)



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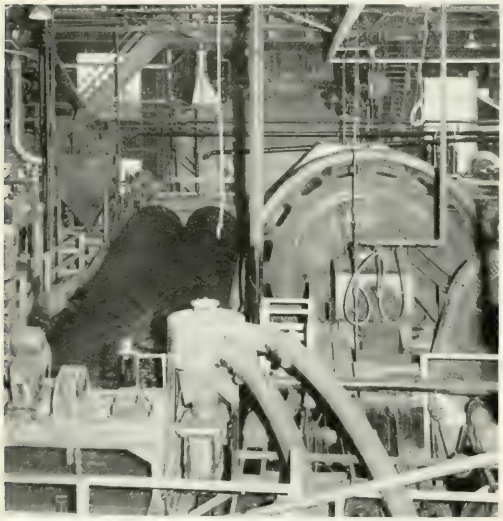
TACONITE . . .

(Continued from page 26)

is then fed on the slowly moving bed of the sintering machine. Here it is subjected to heat, which followed by an air blast, begins the process that fuses the mixture of coke and ore into a hot clinker-like mass. A rotary cooling bed 46 feet in diameter catches the sintered material as it comes from the machine. The red hot material is allowed to cool slowly, and then removed from the cooling bed by a mechanical rake to a loading hopper where it is transferred into railroad cars for shipment to ore loading docks.

A somewhat similar product is made in the nodulizing kiln, where a combination of heat plus the rotative action of the kiln produces egg-sized lumps of the fused fines. This brick-lined kiln, which is one of the largest in ragular use, is 12 feet in diameter and 350 feet long. The ore fines are first mixed in pug mills and fed into the end of the rotating kiln, which is heated to a high temperature by pulverized coal burners. Under heat, the ore fines form into nodules which are discharged from the kiln, cooled by an air blast, and transferred to a shipping bin for loading into railroad cars.

In addition to the quantities of ore processed, full time operation of the plant requires 50,000 tons of coke, 35,000 tons of coal, and 35,000 tons of limestone annually to produce the finished product. Oliver operates the plant on a 24-hour daily schedule, and its capacity is approximately 500,000 tons in sinter and nodules annually. The products from this experimental plant are undergoing much testing to determine their handling and shipping qualities as well as their behavior in the blast furnaces.



Erie pilot plant on the eastern Mesabi, where chunks of taconite are crushed, ground, and processed to remove impurities.

The Reserve Mining Company, with a pilot plant located at Babbitt, Minnesota, agglomerates their taconite rock by the pelletizing process. The company is also constructing a pilot plant at Beaver Bay on Lake Superior's north shore. In the operation of these plants, the water used to wash and carry the taconite through the many processes will come to about 35 billion gallons per year, and the tailings or waste sand washed away and dumped each year will amount to 95,000,000 cubic feet.

The oldest taconite plant, located at Aurora, Minnesota, and operated by the Erie Mining Company, also uses the pelletizing process for agglomerating magnetic taconite. It is capable of turning out 200,000 tons of concentrate per year and has been operating since 1948.

In the pelletizing process, the wet taconite concentrate produced by crushing, grinding, and magnetic separation is rolled into balls in a balling drum, and baked in the pelletizing furnace. This agglomeration process produces taconite pellets containing as much as 70 per cent pure iron content. Although it takes three tons of taconite to produce one ton of concentrate, the use of taconite produces 20 per cent more pig iron from a furnace than natural ores. Another advantage of the factory-made ore is that the same measure of ingredients always go into the best furnace, because the iron in every hopper of pellets can be kept uniform. This assures better production from the furnaces.

CONCLUSION

Developing the new taconite industry on the Mesabi will require huge investments in plants and equipment. Estimates vary as to how much, but it is generally agreed that it will require well over a billion dollars in new plants to equip Minnesota's taconite industry.

Up to the present, almost half-a-billion dollars has been committed to building new taconite processing plants in Minnesota. This huge sum has been invested solely by American steel businesses in this future source of "factory-made" iron ore.

Throughout World War II, and during each of the post-war years, the demand for iron and steel products has continued at high levels, carrying with it a corresponding high demand for iron ore. Steel ingot production, which reached 105 million tons last year, is expected to total 110 million this year, 118 milion in 1953 and 120 million in 1954.

To meet these increased demands for steel, it will be necessary to obtain more iron ore from South America or other foreign sources and to continue to develop the taconite and low-grade ores of the Lake Superior region.

For years the iron ore mining industry has maintained a record of dependability to the nation that remains unchallenged. The industry will continue to fulfill its responsibilities and obligations to the people of this nation by devoting all its energies toward establishing a taconite industry on a sound, firm basis.

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ACKNOWLEDGEMENTS

The Public Relations Department of the Oliver Iron Mining Division, U. S. Steel Company, located at Duluth, Minnesota.

The Electric Machinery Mfg. Company, Minneapolis, Minnesota.

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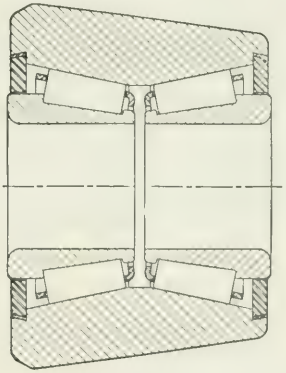

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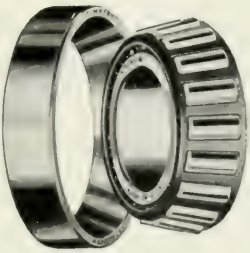

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MINE RESCUE . . .

(*Continued from page 22*)

used beyond its normal life might be dangerous and there have been fatal results. It is emphasized in this course that the gas mask should be used only where a flame safety lamp will not be extinguished. The M.S.A. All-Service Gas Mask is the only gas mask permitted by the United States Bureau of Mines during rescue and recovery work. The main test demonstrated in class is air tightness. The Gas Mask is being worn by the fifth and sixth men from the left in row two. The Gas Mask and flame safety lamp is shown by the first man on the left on the bottom row.

Each man in the class is trained with all of the above apparatuses using a life line and a horn signal as would be used in actual rescue cases. The life line is a rope on a reel that is placed at a fresh air station. Each member of the rescue team, which usually consists of five men, holds on to the rope as they advance through the mine. At no time do they let go of the line for it is their only means of communication with the outside. The captain leads the men by a system of signals made by a small hand horn. He communicates with the outside by a system of jerks on the rope.

At the completion of the course, an oral examination is given by W. W. Kessler, Federal Inspector for District VIII of the United States Bureau of Mines, Vincennes, Indiana. Those completing the course receive a pocket-size card and a certificate from the State of Illinois Department of Mines and Minerals and from the United States Bureau of Mines.

FIRST-AID

The first-aid section is offered after the Rescue course has been completed. This fall semester, there were two women enrolled. They are wives of two mining students. This course is offered from six o'clock to ten o'clock on Monday nights for five weeks.

There are six fundamentals taught in this course. These fundamentals are:

1) Artificial Respiration.
2) Control of Bleeding.
3) Care of Physical Shock Victims.
4) Care of Wounds and Burns.
5) Care of Fractures and Dislocations.
6) Transportation of the victim.

Three types of artificial respiration are taught and practised during the entirety of the course. These are the Shaefer, Sylvester, and the new push-pull type called the Eilson. Emphasis is placed on the continuation of artificial respiration after it has once been started. There has been cases where a person revived after 72 hours of application. The conditions that warrant artificial respiration are: electric shock, gas poisoning, drowning and suffocation.

The eleven pressure points on the body that check arterial bleeding is the first principle taught in the second fundamental, control of bleeding. Along with the pressure points, the application of tourniquets and bandages is discussed and practiced by the class.

Physical shock accompanies all forms of injuries. Due to physical shock being the cause of a great portion of deaths after injury, the instructor, during every lecture, asks different students the cause, symptoms, and treatment of physical shock so that no student will forget the importance in knowing all there is to know about it.

The care of wounds and burns is the fourth fundamental taught. The care for abrasion, incised wounds, lacerated wounds, and punctured wounds are the topics discussed in this section. Also, the care of the three different degrees of burns and how to bandage these wounds is practiced.

The different types of splints and pressure bandages are taught and practiced in the section on dislocation and fractures. During this study, the care and position of the patient is exercised.

Transportation is the last of the fundamentals of first-aid, but it is in no sense of minor importance. To make one mistake in transporting a patient could cause agitation to the injury and the severity of it could be fatal. A case was cited where a stretcher crew did not check the stretcher to see if it were strong enough to haul the injured person, who had eight broken ribs. When the men lifted the victim, the stretcher was rotten and the man fell to the ground. Two weeks later, the man died. The class is taught how to make an improvised stretcher in case the stretcher to be used is found to be defective. To prevent jarring and swaying of the person during transportation, the class practices a walking pace that checks undue movement of the victim.

Again at the completion of the course, Mr. Kessler gives an oral examination over what was covered. Certificates and pocket-size cards are received by the members of the class from the State and Department of the Interior as before.

To know first-aid is to be one step ahead of death or deformity. Anyone interested in this course should contact Professor R. G. Wuerker of the Mining Department for the course next fall. Remember—THE LIFE YOU SAVE, MAY BE YOUR OWN.

JOY CONTINUOUS . . .

(*Continued from page 9*)

the beam-supported section of the room and well clear of the ripper head as it advances into the unsupported section. There are two built-in timbering jacks, one on each side of the main chassis, as both a safety factor and an aid in timbering operations.

The main chassis receives the coal from the ripper head assembly in its central hopper. From there it is taken by the intermediate conveyer back to the rear conveyer which in turn transfers it to shuttle cars or mobile conveyer units.

A turning radius of forty-five degrees on each side of the main center line and an elevation capability of fifty-nine inches above the baseline allows the rear conveyer to multiply the radius where the continuous miner can work and still be reached by shuttle and conveyer units.

The Joy Continuous Miner with its auxiliaries — the shuttle car and the mobile conveyer belt — have started a new method of mining which has revolutionized the coal mining industry. This machine — well capable of timbering, making entries, working rooms, taking pillars and split seams and loading, in short completely eliminating the former separate jobs of cutting, drilling, shooting and loading out — has turned coal mining into a highly skilled mechanical operation, where the laborer is replaced by the machine operator.

Safety is greatly increased and cost just as greatly reduced. Only one comparatively limited area, requiring no trackage, must be ventilated, maintined, supervised and supplied with power. When an area is mined out the pillars are retreated and the area is abandoned completely. With no mined out areas and with the working area considerably reduced, the usual heavy cost of ventilating, pumping and general maintenance of these areas is removed, increasing profits considerably.

The continuous miner is finding uses in other kinds of mines besides coal. J.C.M. units are in operation in Borax mines in Colorado and in Potash mines in the Southwest and France. More are being tried in other types of mines. The limit of versatility of these machines has yet to be found.

The farmer was sitting on his front steps eating a sandwich when a hen zoomed by with a rooster in hot pursuit. Suddenly the rooster put on the brakes, slid to a halt, and began picking up the crumbs from the sandwich.

"Dern," muttered the farmer in disgust, "hope I never get that hungry."

Takes a lot to lay a carpet in the jungle

The scene is "darkest Africa".

But Africa is lightening. Man's quest for minerals, for new areas for agriculture and trade, is slashing ultra-modern, glaring-white air strips in once impenetrable jungle.

Those pavers, portable air compressors, pumps and air tools—such as you might see working a city street—are Worthington Blue Brutes going to "lay a carpet" in that hole in the jungle.

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And illustrates, too, how the unique American talent of *diversification* helps public, employees and stockholders. For Worthington makes many things—not just construction equipment and pumps, but also engines, water works machinery, power transmission, petroleum equipment, air conditioning and refrigeration, many others.

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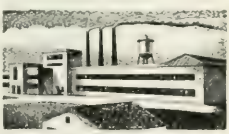

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Petroleum Products—compressors · engines · pumps · chilling equipment · refrigeration · decoking systems

More Abundant Food—compressors · fertilizer mixers · air conditioning · refrigeration · pumps

COMPUTER . . .

(*Continued from page 20*)

between the time before the action cycle, when the memory is still regenerating, and the time afterward when it has returned to regenerating but while the "have used memory" signal is on.

A large part of the control is devoted to setting up the proper clear and gate sequences for the registers. Fundamentally, of course, everything that is done in the arithmetic unit must be a combination of sensing flip-flops, adding, clearing, and gating. The decisions about these things are made after certain combinations of digits, called orders, have been decoded with logical circuits. The number of orders that is actually necessary for the convenient coding of the kinds of problems which the Illinois machine is expected to solve is probably between 20 and 30, and this many orders can be described with 15 flip-flops, ten of them being needed for memory addresses. A decoding matrix using five flip-flops would then be used to cause one of 32 wires to be actuated whenever the corresponding order is presented. However, since there are 20 digits available for an order of which only ten are needed to describe the 1,024-memory locations, we can use as many as ten for an instruction. Actually eight have been used with the result that the number of tubes required for decoding has been decreased and the number of orders has been increased. The number of orders which has actually been used in programming is about 50, some of which were not forseen when the control was designed. A complete matrix is not used, the decoding circuits being made up of a number of submatrices.

The arithmetic of the machine is one which handles numbers in the range from -1 to $+1$ (actually excluding $+1$) and which carries negative numbers as complements relative to 2. In particular, the method by which multiplication is carried out is not used, as far as we know, in any other machine. (This method was suggested by Mr. J. E. Robertson of the University of Illinois.)

Multiplication without roundoff by two positive numbers poses no problems. If an operand x is negative, the machine holds the number $2+x$, and if the sign digit of x is ignored multiplication by a positive y gives the result $xy+y$ so that subtraction of y will give the desired answer. If x is the multiplier, there is no difficulty because y is available at the end and can be subtracted. But if x is the multiplicand, y is lost during the process of shifting to inspect its digits. Hence it must be subtracted during the stepwise formation of the partial products.

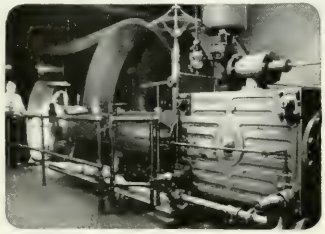
The Illinois machine multiplication scheme makes no distinction between positive and negative multiplicands. This is accomplished by making an algebraically correct division by two at each step, and always adding the complete multiplicand with its sign if an addition is required. No corrections are required at the end. The same circuits are used as those which carry out the right shift order, this order giving a correct division by 2 in the accumulator.

The problem posed by the roundoff, which requires that the product be rounded to a sign and 39 places after the addition of 2^{-40}, has been solved by doing the roundoff before the multiplication begins. If there is no roundoff, the accumulator is cleared and the product xy is formed. If there is to be a roundoff, the accumulator is cleared, 2^{-1} is gated into it, and the quantity $xy+2^{-40}$ is formed. Since the accumulator holds only the sign and first 39 digits of the product, it holds the rounded product.

This method of rounding off has the advantage of being fast, because there is no need to do an additional step at the end which involves waiting for carries in the adder, and it also provides the facility for gating the digit 2^{-1}, into the accumulator for other orders.

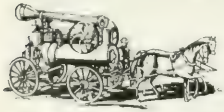
(*Continued on page 40*)

Demonstrating the Dependability of FRICK Equipment



The portable steam engine shown at left was operated in Virginia from 1872 to 1949: the Corliss type above, built in 1891, is still running at Irwin, Penna. Another Frick Corliss, shipped in 1888, is still going strong at Weldon, N. C.

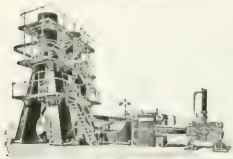
Frick Company was established a century ago for making engines and farm machinery. For over 70 years it has pioneered in building refrigerating and air conditioning systems. Frick compressors commonly achieve service records of 40 years; many have run 50; some even 60!



This portable engine still runs after 72 years' active service.

The whole story of Frick equipment is told, with 200 illustrations, in the Centennial History just published: send $1 for your copy.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.



The largest Frick refrigerating machine ever built (1896), was 50 ft. long; in service for Armour 40 years.

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THAT SPEEDS WORK, SPARES MEN, SLASHES COSTS

No other Mobile Crane of this type has all the features of ***KRANE KAR***. More goes into ***KRANE KAR*** . . . you get more out of ***KRANE KAR*** . . . more speed, more work, more safety. Loads and Unloads freight cars, trucks, trailers . . . Stacks and Stores . . . expedites Plant Maintenance.

KRANE KAR handles steel stock and forms of any shape or size within capacity (or scrap when equipped with magnet); transmission cases, motors, crankcases, transformers, etc. Works in tight quarters, low headroom, up and down ramps . . . anywhere, in plant or yard. Often cuts handling costs to 8¢ a ton.*

Safest Crane in its class, minimizing injury risks to men, materials, machine. ***Self-Stabilizing:*** dangerous use of jacks or stabilizers eliminated. ***Automatic Power Cut-Off*** at extreme positions of Boom-Swing or Topping. ***Automatic Braking*** of Load and Boom Lines. ***No Tail-Swing:*** no part of Crane passes over operator's head.

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USERS: General Motors; Bethlehem Steel; Todd Shipyards; Boeing; General Electric; duPont; Pullman Standard; etc.

*Write for case studies.

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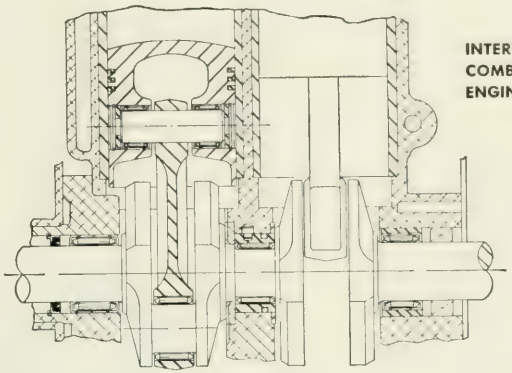
The Torrington Needle Bearing...

for designs where light weight is important

Reducing weight without sacrificing performance is one of the major considerations in many modern products. Designs are streamlined to pare off excess weight. New and lighter materials are being used. Components which save even a few ounces frequently contribute greatly to product success.



Needle Bearings reduce weight and size while providing high radial load capacity.

Light Weight Plus High Capacity

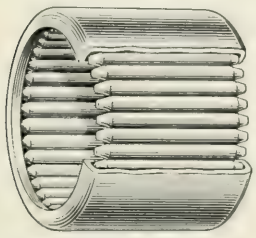
The unique design of the Torrington Needle Bearing makes it ideal for a wide variety of product uses. It consists of two components — a thin, hardened outer shell and a full complement of small diameter rollers. Its many lines of contact give the Needle Bearing a greater rated radial load capacity than any other type of anti-friction bearing for its size and weight. Conversely, for a given load capacity, a Needle Bearing is the lightest, most compact bearing available.

Weight Savings In Related Assemblies

In addition to the light weight of the Needle Bearing, its design permits sizable reductions in the size and weight of the related assemblies. Its small outside diameter allows the use of smaller housings. And, since a press fit in a simple straight housing bore is adequate to locate the bearing, no complex shoulders or housing modifications are required. The hardened shaft usually serves as the inner race, saving additional space and weight.

These advantages, plus its high radial capacity, have made the Torrington Needle Bearing particularly attractive to the designers of aircraft, portable power tools, small gasoline engines and many other products where weight and space are important factors.

In future advertisements of this series, other features of Torrington Needle Bearings will be discussed. The new Needle Bearing catalog will be sent on request.



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NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS

COMPUTER . . .

(*Continued from page 36*)

In connection with a shift order a digit can be put any place in the accumulator without requiring additional memory storage space.

Power Supplies

The machine uses about 8.8 kw of a-c power to operate the filaments of the vacuum tubes.

The d-c power consumption is:

−2,000	volts	0.08	ampere
− 300	volts	15.7	amperes
+ 100	volts	11.0	amperes
+ 150	volts	3.2	amperes
+ 300	volts	6.4	amperes
+ 680	volts	0.35	ampere

The −2,000-volt and the +680-volt potentials are obtained from vacuum tube regulated power supplies which were built at the University of Illinois.

The intermediate four voltages supply the bulk of the d-c power for the machine and insofar as possible all circuits have been designed to use these voltages directly without additional regulation or "bleeders." In a few cases such as adder circuits "odd" voltages are required and these are furnished by a "bleeder" which supplies voltages for vacuum tube grids where the current drain is very low. These four "main" voltages are furnished by commercially built and controlled rectifier units which are regulated against line voltage changes and fast and slow load changes to ±2 per cent.

All of the d-c loads are divided into separate circuits of about 3 amperes each and arranged with individual fuses in such a way that the failure of any individual circuit will open a relay thus turning off a "holding circuit" on all of the d-c power.

Conclusion

A variety of complex problems have already been solved on the Illinois computer. A few of them are: Analysis of structures by members of the Civil Engineering Department, investigation of rubber molecules for the Chemistry Department, statistical analysis of data for the Psychology Department, numerical solution of sets of differential equations, and calculation of 20,000 decimal digits of e. Judging from the work accomplished by the computer thus far it seems safe to conclude that the Illinois machine will prove to be a valuable tool in all phases of University research.

"Use Lump-O-Soap. Doesn't lather. Doesn't bubble. Doesn't clean. It's just company in the tub."

MINING . . .

(*Continued from page 11*)

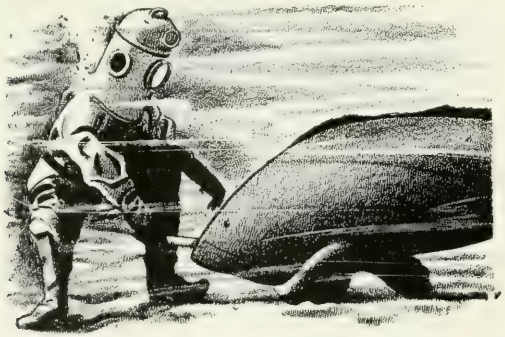
background so that he may intelligently carry on work in any of the special fields.

Freshmen and sophomores in metallurgical engineering take basic courses in chemistry, physics, math, drawing and rhetoric. During the junior year they take up physical chemistry, principles of physical metallurgy, metallurgical calculations, pyrometry, ferrous metallography, electrometallurgy and resistance of materials. The senior year takes up elements of electrical engineering, nonferrous metallography and metallurgy, advanced materials testing, advanced physical metallurgy, alloy steels, and the metallurgy of deep drawing and pressing.

Mining engineering is concerned with the removal of useful materials from the earth's crust. It consists largely of the application of principles of geology and of civil, mechanical, electrical and chemical engineering to the discovery, exploration, development and extraction from the earth of economically valuable materials.

Several branches of mining offer opportunities to engineers. Coal mining has a profound effect on our national

(*Continued on page 44*)



The wonders of the ocean's floor are duplicated in two giant tanks at Marine Studios, at Marineland, Fla. More than 30,000 live undersea specimens are presented in their natural setting, and into these tanks are pumped more than 7,000,000 gallons of sea water per day.

Okolite-Okoprene cable was selected as the most reliable means of supplying power to the motors which pump this water. Power is taken from a 2300-volt circuit and stepped down to 220-110 volts, for motors ranging from ¼ to 30 h.p.

The corrosive influence of salt water and salt air has virtually no effect on the tough Okoprene sheath which protects Okolite-Okoprene cable.

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But I haven't majored in aeronautical engineering

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See your Placement Officer today for the details on Lockheed's Aircraft Training Program for engineers, as well as the better living conditions in Southern California.

If your Placement Officer is out of the illustrated brochures describing living and working conditions at Lockheed, write M. V. Mattson, Employment Manager.

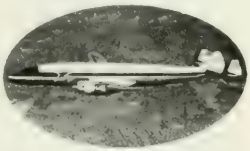
Lockheed Aircraft Corporation

Burbank, California

This Plane made History

The P-38 Lightning – first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History



The Super Constellation – larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

This Plane will make History

The jet of the future – the plane you will help create – belongs here.

This plane – which exists only in the brain of an engineer like yourself is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.

MINING . . .

(*Continued from page 40*)

economy. The United States has more than 50% of the world's known coal reserves. Metallic mining refers to the mining of such metals as copper, gold, silver and zinc. Non-metallic mining takes in the mining of such minerals as potash, limestone, silica, and sand. Also, a tremendous field is opening up in mine research. Much information about explosives, the physical properties of rocks, and mine safety problems is vitally need today.

The curriculum in mining engineering is designed to give the student instruction in fundamental problems of mining engineering, as well as to provide a broad background in engineering as a whole. Freshman and sophomores in mining take about the same basic courses as do underclassmen in metallurgy. They also receive instruction in geology, fuels, and elements of mining. In the junior year courses are given in surveying, economics, electrical engineering, fluid mechanics, dynamics, and resistance of materials. The senior year covers mine administration, mining methods, mineral dressing, mine haulage, hoisting, and pumping, the geophysics of mining, engineering metallurgy, mine examination and valuation, mining design, coal preparation, and mine ventilation.

Since the number of men graduating with degrees in mining or metallurgical engineering is small, and the demand for these men is great, job opportunities are very good in both fields. Metallurgists can be found in research, development, or as part of management in various capacities such as the director of a laboratory for control of quality, a director of research, or a superintendent of heat treatment. In addition, every business which is concerned with the production, processing, or use of metals and alloys is finding it more and more difficult to remain successfully competitive without the services of a metallurgist. This realization of the part of industry is creating many new positions for metallurgical engineers.

The mining engineer may find his life's work in any one of several aspects of mining. Mining administration, practical mining engineering, mine examination, consulting engineering, fuel technoloy, mining geology, mining sales and research are some of the avenues open to him.

A mining or metallurgical engineer must have a genuine interest in things that engineers do, such as mathematical analysis, design, research, and development. He must have the ability to think logically, a willingness to work hard, the ability to cooperate with others, and the capacity to assume leadership. If a student possesses these qualities *plus* a great interest in mining and metallurgy, he will never regret having chosen mining or metallurgical engineering as his life's work.

MINERAL INDUSTRIES SOCIETY

The Mineral Industries Society started off this semester with its annual smoker which was held at the Illini Union on October 8. The purpose of this meeting was to acquaint the freshman and transfer students with the members of the society and to offer them an opportunity to meet their instructors on an informal basis.

This meeting was followed by the first business meeting of the year which was held on November 12. The following men took over as officers for the fall semester: Richard L. Sloan, president; Wilford Couts, vice president; Warren Holland, secretary; William Stoewer, treasurer. D. R. Chedsey will continue to serve as faculty advisor. the society's monthly meetings include either a lecture or a movie which is of interest to both the Mining and Metallurgical students.

One of the society's annual events is a softball game held every spring between the Metallurgy students and Mining students for a fur-lined chamber pot.

WHITE PINE . . .

(*Continued from page 13*)

on slight grades above the roadways.

Considerable effort was necessary to design a dwelling unit that was functional and yet in keeping with the moderate cost to provide such a unit. It is a credit to the architectural skill of PACE Associates that they have achieved such a unit and made it available in a variety of forms and methods of placing to avoid the all too common "mining town" appearance. They have provided one and two bedroom dwelling units so arranged in the over-all townsite plan that no two identical dwelling units are adjacent to each other. The initial plan calls for the construction of ninety dwelling units with an additional fifty units to be under construction upon completion of the initial order. The first units were commenced in August, 1952, and construction has approximated a production line basis ever since.

A tentative plan calls for the construction of a series of prefabricated type dwellings, again to inject variety into the over-all layout, and several homes of this form are being investi-

(*Continued on page 48*)

● For many years K&E has pioneered in the manufacture and development of finest quality surveying instruments. K&E surveying instruments are renowned all over the world for their superb performance under conditions of all kinds, for their magnificent workmanship and for special features that come of progressive ingenuity.

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If you are looking for a future with real opportunities for growth and advancement, Square D has much to offer. You'll get *sound, thorough* training. Square D is big enough to be a leader in its field... but not too big to give *individual* direction to its men. And of real importance—you'll be entering a field which is basically sound and constantly expanding. Worth thinking about, isn't it?

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SQUARE D COMPANY

WHITE PINE . . .

(Continued from page 44)

gated. It is not too remote to believe that most every modern type of dwelling unit will find its way into the White Pine townsite to permit the townspeople to express their preferences for the type of house that suits their fancies. This all in contrast to the frame, clapboard dwellings found in abundance in the range towns northeast of White Pine and out in the western United States. It is not difficult to appreciate the problems of furnishing a variety of dwelling plans all within the prescribed cost.

To ship the metallic copper to the eastern industrial centers a railroad has been constructed into White Pine from the nearby resort town of Bergland, Michigan, ten miles to the south. The Duluth, South Shore and Atlantic Railroad main line from Duluth to the Soo runs through Bergland and the White Pine spur leaves the main line near the shore of beautiful Lake Geogebic, probably the largest inland lake in the Upper Peninsula. The original rail line into White Pine came from Ontonagon along the southern shore of Lake Superior from a connection with the Chicago, Milwaukee, St. Paul and Pacific Railroad. It was not feasible to reconstruct this track as the harbor at Ontonagon will not accommodate large coal vessels and hauling coal by rail via Bergland was found to be more economical. Also the Ontonagon route would require the bridging of many small streams which drain into Lake Superior.

Preparing to pour the roof slab on the White Pine hospital. Designed by PACE Associates and built by the Turner Construction Co., this hospital will be the most modern structure of its type in Michigan's Upper Peninsula.

Electrical energy to drive the machines in the process buildings, and to light the White Pine homes is provided by a special line of the Upper Peninsula Power Company from the hydroelectric plant at Victoria dam, seventeen miles to the east. This monumental structure, over one hundred feet high, was one of the first of the gravity-arch dams in the United States. Behind the dam is jewel-like Victoria Lake, a popular fishing spot.

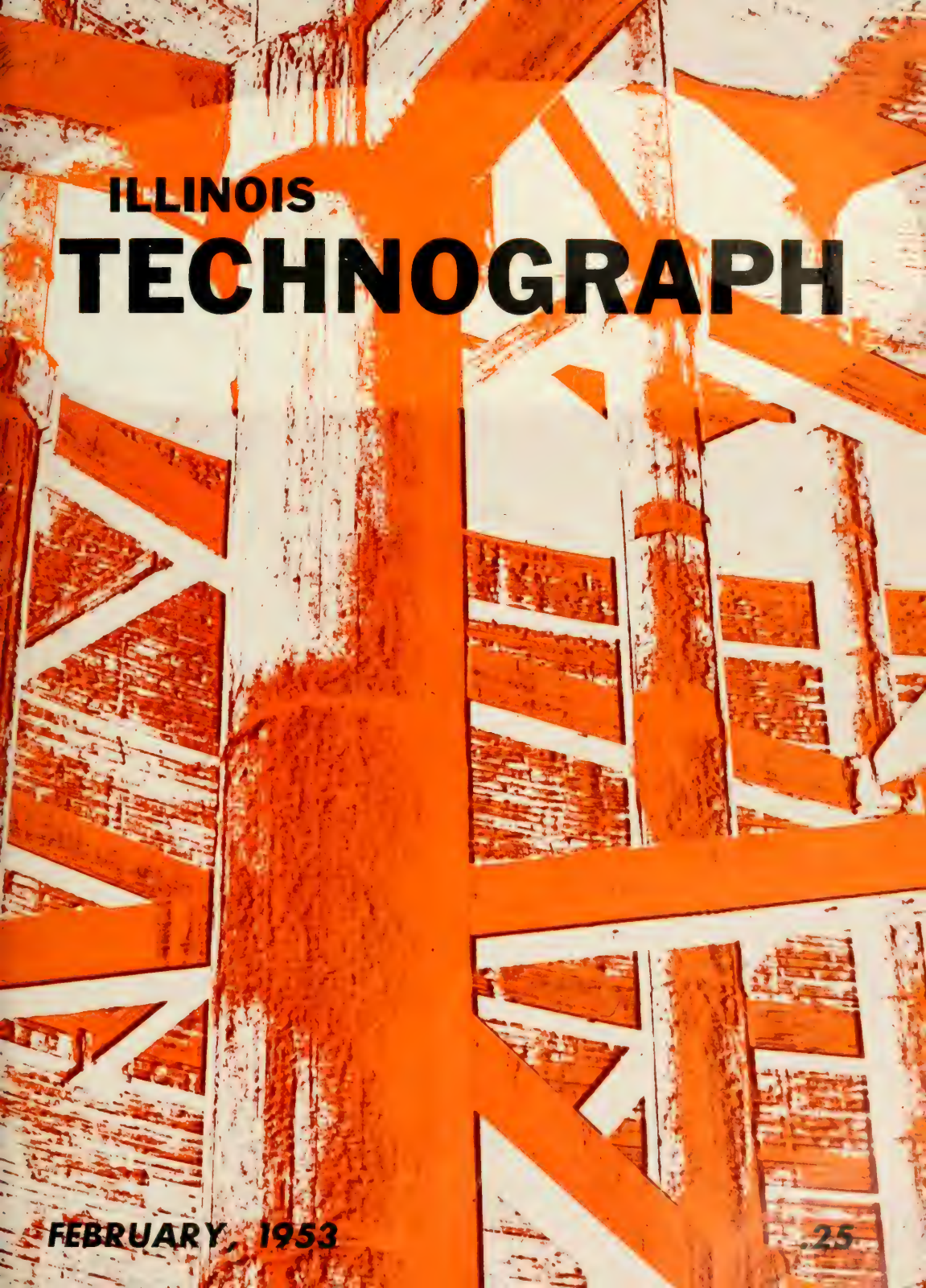
Besides residing in one of the newest towns in the country, White Pine townspeople will have the advantages of a delightful summer climate, close proximity to the famed Porcupine Mountains State Park, opportunities for deep sea fishing in Lake Superior, and hunting for many kinds of game animals that abound in this region. During the construction of the townsite last summer, wild deer and bear were common visitors. Many porcupines and smaller animals are also at hand for nature study.

It has been some time since a town was constructed out of the wilderness, especially in the Middle West. But White Pine is evidence of the pioneering spirit that would make any of our founding fathers proud. The difference between White Pine and the older Middle Western town is engineered progress. White Pine has been engineered and planned for the people and purposes it is to serve. With such a foundation, who can foretell anything but success for America's newest town—White Pine, Michigan.

Excavation for the mine portal in the White Pine works area. This portal leads, on a gentle slope, into the mine shaft. Initial crushing of the copper ore will be done in a building located in the portal to avoid haulage of waste rock.

A man died and left $100 each to an Englishman, an Irishman and a Scotsman, on condition that they each put $10 in his coffin.

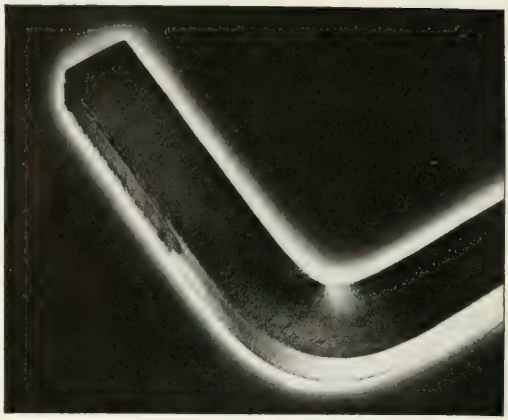
The Englishman dropped in his $10, and the Irishman did likewise. Then along came the Scotsman who put in the coffin a check for $30 and took out the $20.



ILLINOIS TECHNOGRAPH

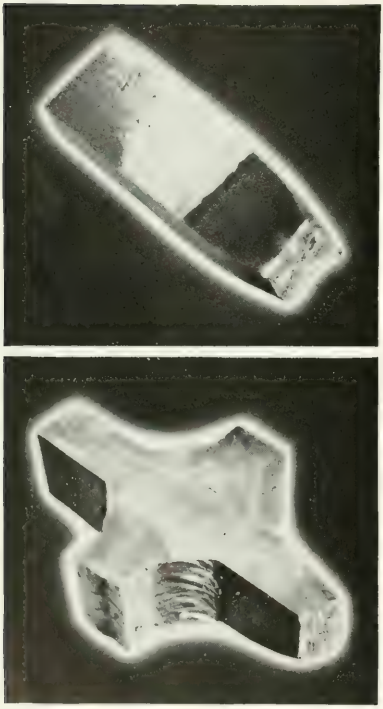
FEBRUARY, 1953

.25



90° BEND AT 98 BELOW! This sample, flame-cut from 1" CARILLOY T-1 plate, was chilled to -98°F., and then bent to a full 90° angle. Even though the raw, flame-cut edge made up the outer radius of the bend, there was no sign of failure!

New steel has yield strength of over 90,000 psi yet remains ductile at 70°F. below zero even after welding or flame-cutting



100% WELD STRENGTH—Tensile tests on T-Steel specimens like these were made to determine the strength of the welds. These welds develop the full strength of the parent metal. Note that breaks occur outside the heat-affected zone, showing that the heat of welding has not harmed the strength of the material. No special pre-heating or post-heating treatments are required beyond those used with ordinary structural steels.

THIS remarkable steel, U·S·S CARILLOY T-1, offers great promise to those who need a super-strong steel that can be welded, flame-cut or cold-formed.

CARILLOY T-1 is unique. It differs from all other very strong steels in important respects: Its yield strength of over 90,000 psi is *not* lowered by welding or flame-cutting. In these operations, no pre-heating or stress-relieving is required. As a result. CARILLOY T-1 can be readily field welded.

Usually, welded steels of such high strength level suffer a loss of ductility at low temperatures unless elaborate precautions are taken in the welding operation. In striking contrast, notched bend weldability tests show that T-1 steel will remain ductile and tough down to the lowest atmospheric temperatures. As a matter of fact, T-1 steel, after flame-cutting, has been bent to a full 90° angle at temperatures as low as –100°F., without any sign of cracking.

Service tests show that CARILLOY T-1 is well suited for extremely abusive service, and the fact that it can be field welded should greatly lower the difficulties and cost of major repairs. In applications in which tension is the principal stress, thicknesses can often be reduced to one-third of those required with ordinary structural steels.

CARILLOY T-1 steel is another result of United States Steel's active research program which has enabled manufacturers to improve their production methods and make better products, too. All over the country, trained U. S. Steel engineers and metallurgists are constantly at work on problems like this, finding better ways to make and use steel. United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

USS

UNITED STATES STEEL

The Door . . .

Tony kicked the door open. He always kicked it open. There wasn't anything in his hands that hindered him from opening it like a normal door, but this door was different. To Tony the only reason God put it on earth, was so that it could be kicked.

To a casual observer this door wasn't much different from any other door in the slums. A haphazardly nailed board extending from top to bottom evidently held it together. The lock was broken off, but then most of the door locks didn't work in this tenement district. To a casual observer this door wasn't different from any other door.

But to Tony it was different. It wasn't a door to him, it was an ugly reminder. The lock used to work, and at one time the door wasn't cracked, but that was long ago. So long ago he could hardly remember. But he did remember. He remembered that night long ago when his sleep was broken by his old lady's and old man's yelling. Ma wouldn't let his old man in.

"You're too damned drunk," she said.

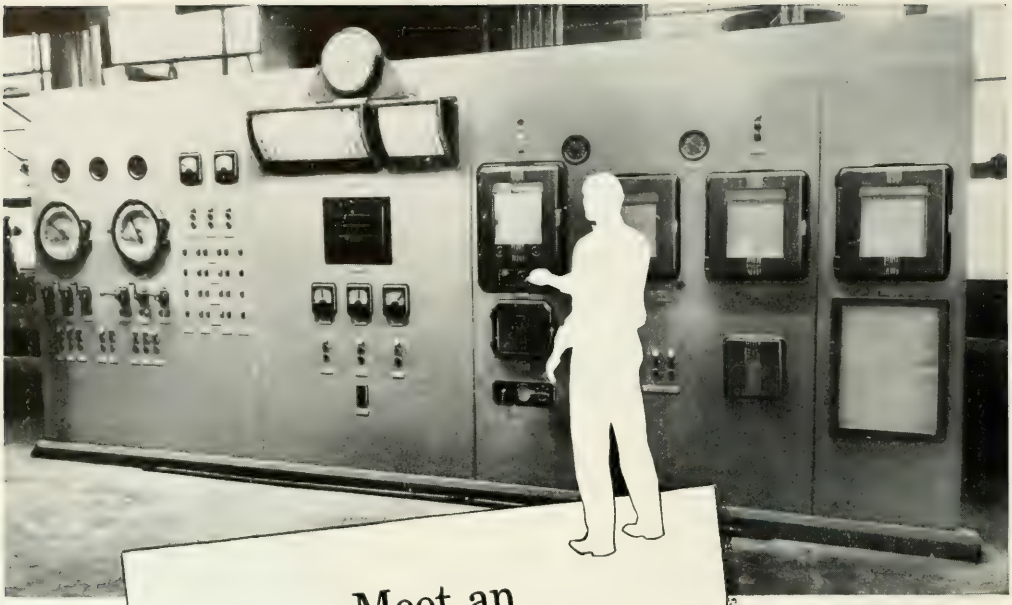
"I'll knock the living devil out of you when I get in there," he said.

A few hard bumps from pa's shoulder and the lock gave way. God, but ma took an awful beating that night.

The lock had been fixed a couple of times but pa always broke it.

The door was more than a reminder to Tony, it was a symbol. Like the pearly gates were a symbol of the entrance to heaven, this door was the entrance to living hell. The entrance to filth, sickness, and misery. The entrance to all he detested. Tony gave the door a harder kick and walked in.

WILLIAM RICHRATH



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volume 68 number 5

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our cover

This month, we have reproduced an original design by James Reed. In this interesting three-dimensional form, the strength and rigidity of reinforced concrete construction is emphasized. (Cut courtesy ARTS & ARCHITECTURE magazine)

our frontispiece

Athens, Greece: The Parthenon. 5th century B.C. An expression of the static "post and lintel" construction of the Greeks. Executed in Pentelic marble with subtle refinements such as the slight convexity and inward inclination of the columns. (Photo by Mrs. A. Schneider)

The History of Architecture

by Professor Alan K. Laing

In the *Peabody Sisters of Salem*, Elizabeth is reported as saying that the function of history is "to deliver the mind from the thralldom of the present and to prepare it to comprehend the future." These are also functions of architectural history. If Joe Jones knows only current architecture, he possesses a very limited frame of reference. For example, he has little or no idea of the term "monumental." He is unaware of the powerful emotional response engendered by the superb integration of architecture, painting, sculpture, and other arts achieved during the Gothic period. He is equally blind to the magic of Baroque space and light. Nevertheless, he will probably talk about monumentality and space and light as though he knew much about them. Such presumption can be likened to Joe's knowledge of the spectrum if he knows only the visible spectrum. A view of the time spectrum of man's building achievement should, therefore, be part of every architect's equipment. In the age of Thomas Jefferson it was considered a necessary part of every gentleman's equipment.

Corollary to this aim of providing an architectural frame of reference is that of helping the embryonic practitioner (or interested observer) to locate himself with relation to the whole—to establish his 1953 position in the total sweep of intellectual history, cultural history, architectural history. How else can he know which way to swim in the choppy seas of contemporary endeavor? How else can anyone prepare one's mind to comprehend the future? Is Le Corbusier's Marseilles apartment building more rationalistic than the Parthenon? Is rationalism in architecture the most promising road, the road we want to develop into a six lane highway in the second half of this century? If it is not, what is the most promising road? Perhaps there should be more than one road.

A third function of architectural history is its usefulness as a laboratory for the study of such things as materials and methods of construction, fire resistance, textures, colors, proportions, psychological reactions, and professional relations. What has worked? What has failed? Why? As in economics, the answers change but the questions remain the same for each generation. No one can perform many experiments at the expense of a client. In the last laboratory of existing architecture there are many experiments from which fruitful lessons may be drawn. Architectural history searches for those of special significance, and through them, aims to develop sensitivity and value judgment.

(Continued on page 42)

A 13th century cathedral in Amiens, France. This is an example of the dynamic arcuated construction of the Gothic period. The stone vault about 140 feet above the pavement made the cathedral relatively fire resistant. (Courtesy Architecture Library)

The department of architecture building at the University of Illinois.

a saga in professional education . . .

Eighty-six years ago, on May 7, 1867, at the second meeting of the Trustees of the Illinois Industrial University, John Milton Gregory, just appointed first Regent, outlined the educational program and established the scope of the new institution. Gregory proposed six primary fields of instruction. One of them, the Polytechnical Department, specifically included Architecture. This was a novel and daring idea, which would soon create for society, university, and profession a resource of major significance.

There can be no doubt of Gregory's genuine interest in Architecture. His own alma mater, Union College, had America's first planned campus, designed in 1813 by the Frenchman, Joseph Jacques Ramee. He had seen in his home area, near Albany and Troy, the erection of numerous fine buildings. At Troy, he had perhaps heard of the proposal in 1849 to add Architecture to the curriculum of America's oldest engineering school, the Rensselaer Polytechnic Institute. Later, from 1858 to 1863, as Michigan's State Superintendent of Public Instruction, he must have followed with interest the chartering of the Massachusetts Institute of Technology in 1861 and its decision in 1865 to include a curriculum in Architecture. No doubt, too, he found strong support in one of his trustees, John M. Van Osdel, the first and most prominent architect in Chicago.

Thus, Gregory shared with President Rogers of M.I.T. the distinction of fixing the character and pattern of collegiate architectural education, which became the accepted model not only for later American schools, but in many other countries as well. Gradually, it replaced both the age-old system of apprenticeship and the earlier European schools that only supplemented office training. For the first time it envisioned a complete and integrated program of studies leading to the professional practice of Architecture.

The unique importance of Gregory's own decision lay, however, in establishing architectural education within the framework of a great public university dedicated to serve all citizens of the state. In the Midwest of the time, just emerging from frontier conditions, architecture must have seemed a gratuitous luxury, but the measure of his vision is indicated by the fact that for more than a quarter of a century, Illinois maintained the only architectural

The four Bronze Tablet members from the architecture department last year, shown with Mrs. Barbour, department secretary. From left to right, Einsweiler, Eberhard, Mrs. Barbour, Dabbert, and Schersten. (Photos by Architecture Department)

ILLINI ARCHITECTS

by Turpin C. Bannister
Head, Department of Architecture

school beyond the eastern seaboard, and that not until 1899 did another state university undertake a similar program. Today, public institutions enroll more than 60 per cent of all architectural students in the United States.

Actual instruction in Architecture at Urbana awaited the arrival in January, 1870, of the first student to request it —Nathan Clifford Ricker. Thus, this beginning followed the first classes at M.I.T. by sixteen months. Ricker's first teacher was the drawing instructor, James Bellangee, a graduate in Civil Engineering of the University of Michigan, who had worked in the Chicago office of the architect, J. W. Roberts. In September, 1871, Bellangee was replaced by Harald M. Hansen, who had had two years of professional schooling at the Bauakademie at Berlin. In the same year, the construction of University Hall, designed by Van Osdel, furnished first-hand object lessons in good construction. Although Hansen remained only a year, he was the first of a long line of European teachers in American architectural schools, and no doubt he did much to set the practical and thorough tone which has always characterized Illinois architectural training. In February, 1873, just eighty years ago, Ricker completed his program and became the first graduate in Architecture in the United States.

In September, 1873, after six months in Europe studying Architecture and architectural schools, Ricker was appointed instructor and began an eventful career which ended only with his retirement forty-three years later in 1916. In 1878, he received the second graduate degree in Architecture to be awarded in this country, rose to the rank of full professor, and was appointed Dean of the College of Engineering. For eleven years he taught all architectural courses, for thirty-seven he headed the Department of Architecture, and for twenty-eight continued distinguished service as Dean of Engineering. He designed many of the early buildings of the university. In 1897, he played an important part in securing the enactment of the Illinois law for the registration of architects, the first such act in the country. In 1903, he succeeded in establishing at Illinois the country's first engineering experiment station. No one has ever served American architectural education more devotedly or more effectively. His contributions thoroughly merited the honorary degree, Doctor of Architecture, which the University awarded him in 1900.

Under Ricker's guidance, the department progressed steadily. In 1878, it had in Mary L. Page the first woman graduate in Architecture. Ricker supplied much-needed texts by continual writing and by patiently translating key foreign publications. The extraordinary development in Chicago of skeleton construction for high buildings led the department in 1895 to institute, at the suggestion of leading Chicago architects, a new curriculum in Architectural Engineering, the first in the country to provide concentrated training in building structures. The number of students grew rapidlyy. For the first decade, 1870-79, when the university's total enrollment never passed 434, the yearly average in Architecture was 7.7 students. By 1889, the decade's average enrollment had risen to 30.3. In the third decade, 1890-99, this had again increased to 72.2. In 1896, there were nine American architectural schools with a total of 273 regular students, of whom 25.3 per cent were enrolled at Illinois. During Ricker's final decade, the department averaged 106.6 students, but this does not reveal the precipitous rise from 55 in 1900 to 283 in 1909.

(Continued on page 24)

Claes Mellin, from Stockholm, shown receiving the Hasting fellowship from Professor Ambrose Richardson (left) and Professor W. S. Kinne, Jr.

a glimpse of . . .

The City o

Reprinted from the St. Louis Post-Dispatch

Mr. and Mrs. Smith awoke with the dawn. They had to. There was no roof on their house. It was one of the penalties they paid for the advantages of modern living. Smith got up, dressed and pushed a button. The walls of his bedroom, which were made of fiberglass or something equally modern, rolled up like a stage curtain. He waved to his next door neighbor, man by name of Buck Rogers. Buck had just pressed a button too, and the walls of his house had sunk into slots in the ground. Some people liked walls that went down, some people liked walls that rolled up.

Smith looked up at the sky. All he could see was a clear, translucent sort of light which filtered down through a plastic dome.

"What's the weather like outside the dome?" asked Mrs. S. from the kitchen.

"I don't know," said Smith, "until I turn on the TV."

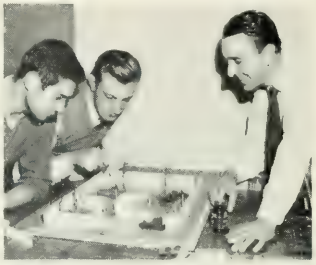
He turned it on, and got the twenty-fifth century equivalent of Dave Garroway. The equivalent was standing in front of a large map of the United States. He drew some lines and symbols, then wrote across the map, "Lousy —don't leave your domes today."

Smith ate his breakfast, consisting of something atomic which had been shot out of a cyclotron, and went to the garage—a concrete slab by the house. His car had never been rained or snowed on. Mrs. Smith followed him.

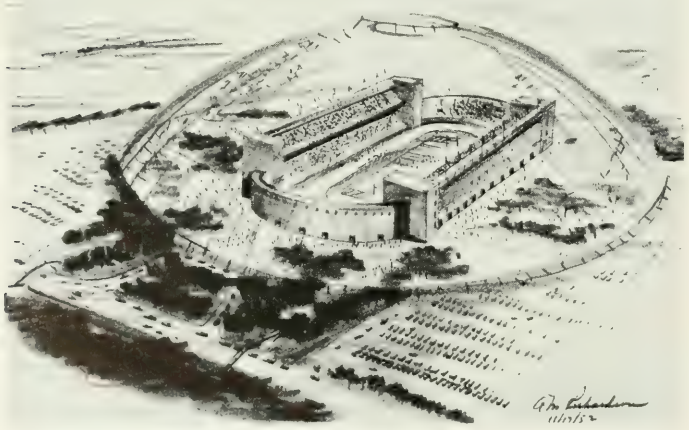
"I wish you'd speak to Junior," she said. "He was up on the dome again yesterday."

Smith said he would. "If I can get away," he added, "maybe we can go outside the dome this weekend. I hear there's snow on the ground; I'd like to see some weather again."

With this, Smith took off and Mrs. Smith set about doing her housework, which consisted of raising the other walls of the house so the municipal atomic dispos-all could do its work. All she had to do was plug it in. It sucked up all dirt and debris and now and then, one of the children.



From left to right, Students Leo Chicca and Claes Mellin, Professor Richardson.



Professor Richardson envisions that Memorial Stadium could be covered with a weatherproof dome. (All photos courtesy of the St. Louis Post-Dispatch)

Any resemblance which this little picture of life in the future has to reality will doubtless turn out to be strictly coincidental. It is merely the writer's projection of what life might be like if the dream of Professor Ambrose M. Richardson come true.

Richardson is the professor of architecture at the University of Illinois who recently startled architectural circles and the world at large with the idea that whole cities could be covered with gas-filled floating domes, giving air-conditioned protection from the weather the year around, not to mention many other things which may or may not be considered advantageous, depending on how you look at them.

It probably should be pointed out at the outset, in fairness to Prof. Richardson, that there is nothing fanatical about

Tomorrow

by Dickson Terry

From left to right, Professor Ambrose Richardson and students, Joe Shafik and Bob Wilson.

him. His hair is not long. Neither is it short in the neo-academic fashion. It's just about average length, as professorial hair goes. There is no strange gleam in his eye. Just a look of friendly intelligence. There is nothing about his appearance to indicate the absent-minded professor. In fact, he was dressed real George in a new tweed suit. He is a youngish, easy-going, mild-mannered man with a friendly smile, a wife and three children. He's even a Cub-master.

His professional background is as reassuring as his appearance. A native of Helena, Ark., he studied architecture at the University of Chicago and Armour Institute. In 1937, he joined the firm of Skidmore, Owings and Merrill, an outfit of national scope and impeccable reputation.

In 1947, Richardson became their chief of design. During his years there, he designed more than $100,000,000 worth of buildings, including the housing and schools at Oak Ridge, and the mammoth housing development put up in New York City by the New York Life Insurance Co.

A year ago he joined the faculty of the university because he wanted to teach. While he has always leaned toward modern architecture, his approach to it is best described as level headed. Not one to be swayed by mere design, he felt that modern architecture, to mean anything, must have meaning back of it. The more he thought about modern architecture, the more he became convinced that all buildings are becoming obsolete. Not just obsolete in design, but tapped for oblivion, so to speak. Out of this thinking grew the idea for the plastic dome, a city in which homes and buildings will have neither roofs nor walls as we know them, and the elements will be harnessed to provide the greatest maximum comfort the year around.

"Architecture has always taken the materials at hand and done the best it could with them," Richardson points out. "The Romans had marble. We have plastics."

When I sat down and talked with Prof. Richardson in his office in the university's Architecture Building — a Georgian affair which seemed to grow obsolete before our very eyes—I learned that the professor had never dreamed his idea of a plastic dome to cover and thereby aircondition whole cities would make people stop dead in their tracks so to speak, and wonder what's with the professor.

"In a way," he said, "it's the ultimate realization of a trend. As I have said, inventive architects have always taken the materials at hand and done the best they could with them. The greatest innovation in recent years has been in the use of steel and concrete. Only recently have we started exploring the possibilities of the new plastics.

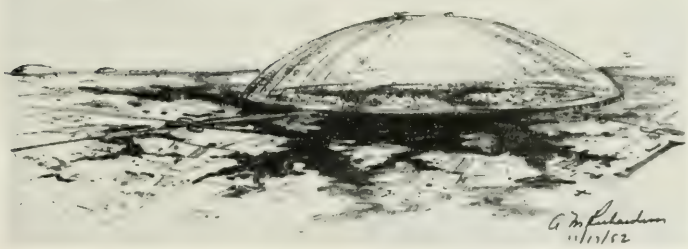
"Now there is another trend which bears on this—that is the trend toward great enclosures in space; that's what the big trend is going to be in the long run. Then buildings will become obsolete.

"We are always working with two constants, the human being and the weather. We have to cope with both. The great change will come in buildings (or canopies) which have an exterior shell which holds the weather out. The interior will then become flexible and can be adjusted to trends in science."

Examples of this trend, Richardson pointed out, are found in Lever House, the New York home of Lever Bros., and in the United Nations building. They are good examples of this trend as far as it goes.

"But architects," he said, "are al-

(Continued on page 38)



A city of the future covered with a dome. On the left horizon are shown two other domed cities.

Architectural Engineering

by Tom Tucker, Ch.E. '53

Almost as old as the University of Illinois, itself, the department of architecture is second only to the department at M.I.T. in years. Shortly after this university was founded in 1868, the son of a building contractor entered it to learn more about his father's business. There was no curriculum in architecture at that time, so he had to choose from the various courses offered in the college of engineering. For his work in this make-shift curriculum, the University of Illinois awarded its first degree in architecture to Nathan C. Ricker in 1871.

After graduation, Mr. Ricker traveled extensively in Europe. Because European architects were more advanced than those in this country, he brought many books back upon his return. These books, like his own interests, covered all phases of architecture. He translated many of these books into English for use as texts in this country.

After his travels, Nathan Ricker returned to his alma mater to teach in later became head of the department. Eventually, Dr. Ricker became dean of the college of engineering. He remained in this office until his death.

The department which Dr. Ricker started has now become the largest of the 60 such departments in this country. The 600-700 students at Urbana and the 200-300 at Navy Pier make up about 11-12% of all students of architecture in the United States.

Although the department of architecture was a part of the college of engineering for many years, it is now in the college of fine and applied arts. Thus it is that the architectural engineer is one of the few engineers who does not get a degree from the college of engineering.

But what is the architectural engineer? How does he differ from an architect? Both men are professional men. Both are concerned with the design and construction of such structures as are not of a limited scientific nature. Their work includes residences, stores, offices, sky-scrapers, bridges, housing developments, and other civic planning.

The problem which faces each man is composed of many parts. He must interpret the immediate needs of his client into a building form. He must advise as to the suitability of the structure to the site and the site to the structure. He must advise on the economic feasibility of the structure with regard to the future. In doing this he tries to look ahead and design for future needs of which his client may not be aware.

The architect and architectural engineer are concerned with all aspects of design. The aesthetic form, the use, the purpose, the structural systems appropriate, the building materials, and the mechanical systems that will be an integral part of the structure must all be considered. While the architect approaches the problem primarily from the view of form, purpose, and use, the architectural engineer is primarily interested in the structural feasibility of the problem and the solution inherent in every structure.

Until 1949, the curriculum in architectural engineering was, nominally at least, four years. Actually, only one student in ten could finish in that time. As a result of the recommendation of professional men, the Collegiate Schools of Architecture, and others, the curriculum in architectural engineering, as well as that in architecture, has been lengthened to five years.

In normal business, the architect or architectural engineer will receive clients who will enumerate their needs, likes and dislikes, preferences, financial means, and real estate.

As the structure begins to take shape in his mind, the engineer will make the

Students viewing a recent architectural design project.

Professor Robert J. Smith and a sophomore design class.

years. The history of architecture is taught so that the student will appreciate the major accomplishments of the past in relation to the problems, knowledge, abilities, and methods of the past. The electives include courses in engineering, landscape architecture, commerce, sociology, and philosophy.

Although the large majority of the department of architecture graduates remain in the fields for which they trained, some have followed such varying careers as law, politics, and dramatics. One is a member of the FBI. Another has become a millionaire in the soap industry, Charles Luckman of Lever Brothers. But essentially, architecture and architectural engineering at Illinois are known because of the many graduates who have made good reputations for themselves in their chosen field.

first rough sketches. Next the building will appear in perspectives, inside and outside. Layouts come next. Eventually, working drawings complete with all specifications are made. Then the architect or engineer will begin his job of coordination between the client and the contractor. He will ask for bids and estimates. He will advise the client upon the proper selection and retainment of the contractor. During construction, he will supervise the contractor and report to the client.

Throughout his work, the architect or architectural engineer is the client's agent or legal representative. He is also the representative of the contractor to the builder. Only by the architect's knowledge of the methods available to the construction industry can the needs of the client be successfully expressed by the building.

Until the second year, the student can choose either the architectural engineering or the architecture curriculum without loss of time. Even at the end of the second year, the time lost by changing curricula is very short. Both undergraduate degrees prepare the student for the examination for registered architects in any state. The architectural engineering degree qualifies the graduate for the structural engineer's examination, although the course is not so set up. The department also offers graduate degrees to students.

While very comprehensive, architectural engineering does not pretend to be a course in business organization or purchasing and merchandising methods, many students enroll in it to get a background for contracting. They feel that the knowledge of what the architect is trying to do will help them help him.

While the architect is spending five years on design and three years on structural analysis, the engineer takes design for three years and structures for four

A modern industrial building combining utilitarian functions with a well-integrated design. The Starch House at Argo, Illinois, designed by De Leuw, Cather & Company, Architects for the Corn Products Refining Co. (Photo courtesy De Leuw, Cather & Co.)

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Introducing the Author . . .

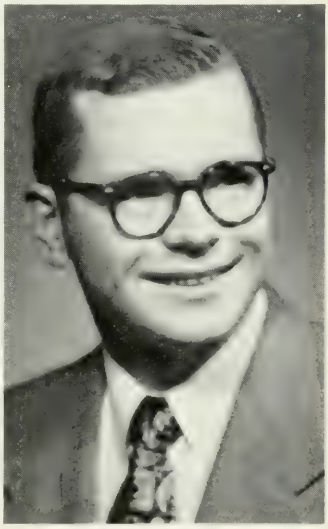
by Bruce Barnett, Cer. Eng. '56

Even though he spends practically all of his time south of Green Street, Robert Wold is an engineer. Bob is a senior in architectural engineering—one of the boys who labor under the common mis-nomer of "drawing their way through school."

When there is no place more exciting to be, Bob can be found in Glen Ellyn, Illinois—his home town. Here he attended Glenbard High School and first became interested in architecture because it combined his two major interests: art and engineering.

Not satisfied with being strictly a student, Bob has entered many other activities to take up the many hours of "spare time" which all architects have. He has served three years on the *Illio* and this year is associate editor of that publication. Concerning the *Illio*, he says, "It involves a lot of time and work, but has its bright spots too. This year I ran the *Illio* Beauty Contest need any hot phone numbers?"

Bob has a 4.3 all-University average, which has been the key to his membership in Sigma Tau, engineering scholastic honorary; and Gargoyle, the "Phi Beta Kappa of Architecture." He is also a member of Scarab, architectural professional; Phalanx, military; and Scimitar, fencing honoraries. But according to Bob, his greatest honor was being elected president of Pi Kappa Alpha in his junior year.



ROBERT WOLD

His achievements were noted at University Honors Day and at the 100 Banquet, a dinner given by the Alumni Association for the 100 students most prominent in campus activities.

Sports are also very important in Bob's schedule. During his freshman year, he numeraled in golf and, although he didn't participate last year, plans to compete again this spring. He tied the U. of I. golf course record of 72 in freshman participation. Bob also enters intramural competition, specializing in ping pong and handball. He won the Sports Fest Championship in the latter as a freshman.

Among his many other interests, Bob lists jazz music as a popular one—especially, "Dixieland at the 1111 Club."

During the summers Bob works in the architectural department of DeLeuw, Cather and Co., consulting engineers, of Chicago. This past summer, however, since he is in advanced R.O.T.C., Bob spent six "very memorable" weeks at Fort Knox, Kentucky.

"After graduation? If I ever do, I'll probably get an invitation to participate in the far-eastern police action, but if I don't, or after I get back, I hope to get a job with some firm specializing in industrial architecture."

LAKE SHORE DRIVE

by Robert Wold, Arch. Eng. '54

On Chicago's near north side, bordering on Lake Michigan and the Loop, lies a part of the city known to many of the local residents as the "Gold Coast." The district is characterized by high-class apartments, apartment-hotels, and good night clubs and restaurants.

It was desired by real-estate men Herbert Greenwald and Samuel Katzin to acquire a good site and build a high-class cooperative type apartment in this area.

The financial setup for cooperative apartments is alluring—and of proven soundness (in the thirties similarly financed co-ops weathered all storms). Besides the initial investment ($6,500 for the small apartments, and $12,000 for the large in the case of 860) their owners pay monthly "rentals" for living in them. This averages $105 for the small and $210 for the large apartments. It covers the tenants' share of the maintenance and operation of the building, taxes, interest on the mortgage, and it will decrease annually for 20 years until the monthly carrying charge is almost halved. Meanwhile, a good part of it is tax deductible.

There are a number of advantages to this particular form of cooperative, which is called in Illinois a Mutual Ownership Cooperative; the mortgage is unusually small for a co-op, 60%; most of the apartments could be rented for more than their present carrying charge; ownership is quite stable because of the heavy initial payments which are necessary; amortization is completed in 20 years on the "enforced-savings" plan; the building is continually establishing reserves which could be used to tide over an emergency period.

But the biggest safeguard in the scheme is its discipline. When you buy a share in this Mutual Ownership Cooperative, you do not automatically buy occupancy. What you buy is an "undivided interest" in the whole enterprise; ownership is segregated from occupancy in the agreement, and you have to move out of the apartment if you do not keep paying your "rent." Your ownership is your railroad ticket, and your rent is your Pullman ticket, as Greenwald puts it. Apartments can be sold or rented at any time, subject to approval by a three-member board.

The over-all requirements of this apartment were about the same as for any other high-rise apartment. It must achieve a fairly high density of population; it must be close to a good system of transportation; and in this individual case, it must take full advantage of the excellent view available. Also, a good share of the area in the individual apartments must be easily used for more than one purpose, or easily remodeled by a new tenant.

The functional requirements of the apartments can be divided into two categories—the private needs, and the common needs. The private needs are the rooms and utilities which are necessary for family living, and are familiar to everyone. The common needs for a high-rise apartment create a little more of a problem. Provision must be made for: laundry—washing and drying, garbage disposal, heating and ventilating, delivery, car parking, supervised child play, large scale entertainment by occupants, and storage of bulk items that are not used very frequently. Some of these requirements could be left out if thought advisable by the architect, and the others could be solved in the most feasible way available, depending on the type of building and the individual occupant's needs.

But, in all, the building must through design and planning, be a very desirable place to live, as the cooperative apartment is to this area something new. It must be an attractive structure; because the proposed site of Lake Shore Drive puts it in conspicuous view of many thousands of people on their way to and from work, and it must leave a favorable impression. It had to keep up the standards of the area, and yet, it had to be built for a low cost in order for it to be a financial success under the "cooperative apartment" plan.

Environmental Integration

Probably no architect ever had a better site for an apartment house than 860 Lake Shore Drive. It is, as previously stated, in a very high-class section of Chicago. It is near the business section, in a social belt, near the lake, and its outlook is not compressed by many other tall buildings nearby. And probably no great architect ever had a more effective advocate than Herbert Greenwald, the young real estate expert who promoted 860 Lake Shore Drive.

The view from 860 is a dream— to the north, Chicago's night-life center and Evanston; to the east, Lake Michigan, to the south, the Chicago skyline; and to the west, the heart of the sprawling midwestern metropolis. The desire to take full advantage of this view probably led to the "glass wall" structure, and I don't think a more effective solution could have been found. Separating the building into two towers instead of the time-worn rectangular solution to the problem allows for more exterior wall space per apartment, and thus more and better view. All the apartments in the 6-room apartment tower, and half of the apartments in the 3½-room apartment tower have a two way view. My only criticism of the use of the plot is that I think the number of apartments in the towers should have been reversed—that is 6-room apartments in the north tower and 3½-room apartments in the south tower. This would give the 3½-room apartments with windows on one side only, a view to the north or south, instead of the west, or weakest view, that some of them have now.

Common laundry and storage for the bulk items, along with heating facilities, were located on the second floor, the floor with the poorest view. Adequate self-parking facilities were located in the basement, thus providing a common garage for car protection. Entertainment lounges, or something of that nature, were not provided because 860 is in the center of Chicago's night life district, and also, the individual apartments are large enough to accommodate a good size party. Supervised child-play areas were also rightfully left out due to the fact that many of the tenants do not have children, and also because there are many public parks within close proximity.

All windows can be washed complete-

ly from the inside, because they are center pivoted, and can be reversed in their frames—a slick idea that saves many scaffoldings and window washers.

In the one brief year of tenant occupancy, complaints have been about garbage removal, elevators, and the thermal situation. The first matter was scheduling of pickups of garbage from a central depository on each floor (the designers didn't want chutes, considering them unsanitary). The elevators were a more serious problem. Although the builders have reliable evidence that these towers both are elevatored up to the standard practice specifications, elevators have been out of service for mechanical reasons at times, piling up traffic. This is being corrected now. (There are two elevators in each building, of 13 person capacity each, self-service, at 400′ per minute. In the more densely occupied building, this serves 175 apartments on 24 floors, with an average peak occupancy of 1.25 persons per apartment.)

The thermal complaints were unique in that some tenants complained about too much heat both in winter and summer.

The winter complaints came from an original misestimate of the balance between the combined radiant and convective system. The ceiling was more emissive than anticipated and, in some cases, is enough to heat apartments without the under-window fin. This was not difficult to adjust.

But the summer sun, particularly on the towers' west sides, was a sterner problem. The drapes which helped insulate cold in winter do not hang near enough to the glass to reflect off excessive sun heat in summer. This situation has called for two solutions. First, air conditioning. There are about 30 room air conditioners in the two buildings, set in the movable low pane of the window (and set by regulation, so that they project into the apartments, not out from the building). There are also 12 built-in air conditioners which temper entire apartments, installed during construction. The other solution is roller shades—close enough to bounce off most of the summer rays before they do much harm in the apartments.

It is my opinion that a standard detail could have been used to clear up the summer sun problem. Possibly putting the outer draperies close enough to the glass to reflect the sun's rays would be the answer, or possibly the use of a special kind of glass. At any rate, this is one of the very few places where the designers slipped up. The installation of roller shades or air conditioning units, either one, tends both to spoil the clean cut, uniform exterior appearance, and to serve as a source of irritation to the tenants.

There has been a small amount of glass breakage due to the wind, but as a rule the ¼″ plate glass panels are strong enough to withstand the worst Lake Michigan can offer.

Placing prefabricated steel skeletal frame sections for welding. (All photos by Hedrich-Blessing)

Technical Aspects

The structure is, in general, two 26 story steel and glass towers. In them are 2842 tons of structural steel and 856 tons of plate steel, all furnished and erected by the American Bridge Co. The frame was put up in the unprecedented time of five months. This was accomplished by the use of modular construction and prefabrication. For instance, all vertical exterior wall sections were jig-assembled and welded on the roof, and then dangled down into place. This was done in several stages by extending the frame of one building up to 12 stories, and then stopping while the jigging went on for both towers up to that point.

All columns are of a 14 inch nominal dimension, but vary in weight from 342 lb. per foot at the bottom to 43 lb. per foot at the top. The whole building is fireproofed with the newly accepted vermiculite plaster, giving all members a fire rating of four hours. All exterior members have a steel fascia plate fastened to their outer side, over the fireproofing, giving the building its clean "steel and glass" appearance, and still preserving its required fire-resistance rating. This steel facing is both structural and decorative; not only does it give a "steel to weather" look, but it provides for attachment of the floor to ceiling windows. The window sections are of aluminum, and were tilted into place from the inside after all the structural work was completed. This too was good, because it allowed the workmen to put in the sash without special scaffolding, using the structural floor as a working surface.

Plate glass ¼ inch thick was used to withstand the winds off the lake. The glass was not put in the frames until all the heavy structural work, which might cause breakage, had been completed. This had its good and bad points; it saved many a piece of plate glass, but there was no protection from the weather for men working on floors, etc.; thus tarpaulins had to be hung between steel members. Small heating stoves were also set up.

Above the second floor level, Cofar floors were used throughout. At the time of construction, Cofar was a relatively new product, and 860 was the first sizeable installation. Cofar is the trade name for 24 ga. corrugated galvanized metal sheets, with steel rods welded to the bottom to take the tension. Because of the strength of this material, only a 3½ inch (to bottom of corrugations) concrete slab was required. The floors went in quickly and economically, as no shoring was used—the corrugated sheets resting directly on angles attached to the floor joists.

A very good detail was used to hang the ceiling from the floor, at a depth equal to that of the floor joists. The space between the floor and ceiling contains finned heating tubes which heat the floor of the apartment above and the ceiling of the apartment below. This space also contains conduits for electrical wiring in the apartments. All wiring and heating elements come up one central shaft in the core of each tower, thus making maintenance and new installation easily accessible.

The entire sub-structure for the building is of reinforced concrete, cast monolithically. The structure is joined at foundation level, and has both a basement and a sub-basement, most of which are used for parking of tenants' cars.

The repetitive vertical use of steel sections across the exterior walls of the apartment towers has raised eyebrows of some architects, who say they are surprised because this is not entirely "functional," (the sections occur not only at the window divisions, but also at the columns of the building frame). These have been called pilasters—usually by people who do not like pilasters. But there could not be an explanation of them more functionally honest than Mies van der Roche, the architect's own. He says:

"It was very important to preserve and extend the rhythm which the mullions set up on the rest of the building. We looked at it on the model without the steel section attached to the corner column, and it did not look right. Now another reason is that this steel section was needed to stiffen the plate which covers the corner column so this plate would not ripple, and also we needed it for strength when the sections were hoisted into place. Now, of course, that's a very good reason," he continues, "but the first reason is the real reason." After you have seen the striking impression created by these steel sections on the building itself, what can you do but agree?

Some architects also say that fireproofing the steel members with concrete, and then covering this with a steel plate is a very false way of giving an impression of exposed structure. This may be true, but the aesthetic impression created is pleasing, and also, covering the exterior of these members with steel plates was as financially cheap a finish as it is possible to obtain.

Aesthetic Aspects

Aesthetically, 860 Lake Shore Drive speaks for itself. It is something completely new and different in apartment design. To the architect, it is a well-proportioned tower of steel and glass-completely functional. To the layman, it is an unforgettable building—he sees it, and marvels at its clean lines and honest expression of structure—he sees the structural columns from the ground level to the 26th floor, and being uneducated as to structure, wonders how so little can support so much—he becomes curious as to interior design, and what is all important, he wonders who the architect was. To both the layman and the architect, it is a pleasing and functional building that is a milestone in modern design, construction, and engineering.

The individual apartment interiors are simple, and yet very appealing. The only really fixed items are the kitchen

(Continued on Page 63)

A view from the west of the completed 860 structure.

The Development of the Microphone

by Dave Cohn, E.E. '55

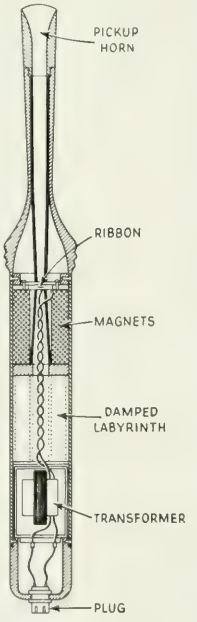
In the field of electronics and sound, the microphone is the first device that starts off the long chain of events that lead to transmission, reproduction, and amplification of a signal. Whether it be the voice of a singer, the roar of a lion, or the sound of a train, there is a microphone designed to capture the particular sound that is heard on this earth today.

The principle of the microphone is quite simple, but it has become a complex, delicate instrument which it must be in order to accomplish the task of faithful reproduction of sound in this modern world, where science craves high-fidelity to the *N*th degree.

Sounds are made up of something vibrating and setting up disturbances in the air. A sound is really a vibrating series of air waves. The faster the vibrations, the higher the pitch or frequency. Furthermore, every material thing tends to respond to any sound which approximates its own frequency characteristics. This can be illustrated by the vibration of piano strings, which are set in motion by your voice.

Suppose that instead of piano strings you have a very thin piece of metal foil, crinkled like a piece of crepe paper. This corresponds to the diaphragm of a microphone. If it is thin and flexible enough, it is capable of responding to a great many frequencies. If this diaphragm were mounted so it could vibrate freely and was suspended in a magnetic field, every time sound vibrations struck the diaphragm, it would produce a minute flow of electricity, varying with the amount and type of sound. This is a way of describing a simple velocity microphone, used chiefly on home recording machines, and where high quality of sound reproduction is not necessary. All types of microphones operate on this basic principle of setting up electrical waves by disturbing a magnetic field with sound waves. The electrical flow, called the "audio wave," is amplified and carried by wire to the radio transmitter, or any other source, as the case may be, that will recreate the original sound to a level that can be heard by the human ear through a loudspeaker.

There are three principal types of modern microphones. The *velocity* "mike" uses a suspended metallic ribbon, which vibrates freely and directly in response to sound waves. Various *pressure* types of microphones use fixed diaphragms or other materials which respond to air-pressure changes of sound waves. *Cardioids* have two ribbons, one mounted freely to act like a velocity, the other baffled to respond like a pressure microphone.



Cross-sectional view of RCA's "Starmaker" microphone. This new type of microphone is designed especially for television.

The directional action of a microphone is extremely important in radio broadcasting, as many different situations are presented which require use of several types of microphones. *Unidirectional* microphones, as the name implies, are sensitive only in one direction. The working area in front of the sensitive side is roughly egg-shaped. Other microphones, especially velocities, are *bidirectional*, and the working area is shaped approximately like a figure eight, with the microphone as the center. *Nondirectional* microphones, usually pressure types, are equally sensitive in all directions and give a circular working area.

Compared to the carbon button telephone transmitter which was used as a microphone in 1920, the latest RCA instruments have reached a point of advance comparable to a side by side display of a sleek new 1952 automobile and an ox-cart of our colonial pioneers. The microphone of today is compact, dependable and capable of a quality of performance once considered almost beyond the reach of engineering design. Following the trend of the times, the present microphones have become attractively streamlined objects, no longer resembling a "pie-plate on a stick."

With the introduction of broadcasting in 1921, it soon became evident that the telephone transmitter was unsuited to its new role. First, this type of microphone was subject to distortion, and secondly, being designed solely for the human voice, it was limited in the frequencies it could handle. Investigation of these problems led to the development of the double-button carbon microphone. In this device, use of a stretched aluminum diaphragm reduced distortion and at the same time extended the frequency response.

As the novelty of broadcasting was gradually superseded by a public appreciation of its commercial and cultural possibilities, improved quality in the transmission and reproduction of sound became of increasing importance. One of the first answers to this demand for improved quality was the condenser microphone, which made its appearance in 1928. It consisted of a stretched aluminum diaphragm two inches in diameter spaced approximately 0.002 of an inch from a back plate and polarized with a potential of about two hundred volts.

The condenser microphone was an impressive technical advance in broadcasting equipment. Its introduction extended the frequency range from 30 to 10,000 cycles and the signal-to-noise ratio was more than adequate for usual program material, but its output was so low that it required a small built-in

amplifier to make it operable. Actually, the capabilities of the condenser microphone were far greater than they appeared at the time. For one thing, this microphone in its form, was housed in a cubical box which made for poor acoustics. Furthermore, a cavity that existed in front of the diaphragm produced a resonance point around 30,000 cycles which was not realized then because of the absence of proper measuring instruments.

Moisture and dirt in the microphone assemblies often resulted in noisy operation and electrical failures. These drawbacks brought the use of the condenser microphone to an abrupt end in 1932 when the velocity microphone was introduced by RCA. The velocity type employed a moving element consisting of a corrugated aluminum ribbon suspended between a pair of pole pieces in a magnetic field. The ribbon which was about two inches long and 3/16-inch wide was exposed to the sound waves in both front and back. Since the moving system was mass controlled by virtue of a very low resonant frequency the velocity of the ribbon and hence the output voltage remained constant with respect to frequency over a wide range.

This microphone had another distinctive feature. Instead of being equally sensitive to sounds from all directions it possessed a figure eight directivity pattern. The ratio of sensitivity on the axis to that for random sound therefore improved by a value of 1.7 as compared to a non-directional microphone, a feature that permitted the operating distance to be increased by a corresponding amount. Some of the original velocity microphones are still in service.

Between 1933-1936 the possibility of a unidirectional or cardioid type of directional characteristic became a reality by combining in a single microphone two microphone units. One unit was responsive to the sound pressure (nondirectional) and the other responsive to the pressure gradient (bidirectional). The outputs of the two elements were connected in series resulting in a directional pattern which is a cardioid.

Dave Garroway is shown using the RCA "Starmaker" microphone This new type of microphone is widely used for television broadcasts.

The first commercial models made were large and cumbersome and found only limited use in the broadcast field. However, in 1936, partially because of the newly available alnico magnet materials, it became possible to reduce the size of the microphone which helped increase its use in other applications. Except for the addition of switches that allowed a selection of directional patterns, the unidirectional microphone remained essentially unchanged until 1944.

Some time previous to 1944, engineers had found that a similar result could be obtained with a single microphone of the ribbon type. In this microphone, one face of the ribbon was coupled to a long folded acoustically-damped pipe; the other was exposed to the sound wave. All that was necessary in order to make such a microphone unidirectional was to introduce a hole of proper size in the pipe close to the ribbon. This principle was first applied to a polydirectional microphone which appeared in 1945. The descriptive term polydirectional was selected because an adjustable opening in the pipe made it possible to obtain a variety of patterns ranging from non-directional to bidirectional.

Thus at the time when the impact of television requirements began to make themselves felt, the news of broadcasters were will satisfied by three microphone: (1) a dynamic microphone, for announcing a remote pickup; (2) a velocity microphone for studio use; and (3) the polydirectional microphone for general use.

The advance of television as a popular medium of entertainment has stimulated another phase in the evolution of the microphone.

In television, microphones are subject to much more rougher treatment than in broadcasting. Their size also introduces problems for the television cam-

A group of typical microphones, showing the development of the microphone from the late 1920's to the present day.

era. The need for a microphone which could be concealed from the camera or which would not be objectionable in appearance brought into being the RCA "Starmaker." The "Starmaker" is a pressure microphone in which the moving element is a ribbon of material identical to that used in velocity microphones but much smaller in all dimensions. This type of moving system is unique in that a tube may be extended from the sound pickup side of the ribbon without unduly disturbing the response characteristics. The result is a slim, easily concealed microphone which weighs only 15 ounces.

The latest microphone introduced by RCA is a semidirectional, pressure type. It was designed to provide AM, FM and TV broadcasters with a small microphone of good frequency response and relative free from the effects of wind and moisture, thereby making it attractive for remote pickups. In the new microphone, sound pressure actuates a thin but rugged diaphragm to which an annular coil is attached. The coil is located in the air gap of a magnetic structure and connected to an impedence matching transformer. The microphone is eight inches high and has a frequency response 60 to 10,000 cycles. Modern styling of this compact device makes it particularly suitable for telecasts of sports, special events, interviews and audience participation programs.

Present development trends are toward further improvement in the ruggedness of boom microphones. The tendency is toward microphones that are more highly directional and that will allow the sound pickup point to be further removed from the action thus permitting greater freedom of camera action. An increase in output level is also desirable in order that a satisfactory signal-to-noise ratio may be maintained.

In 1948 RCA announced the development of a new miniature velocity microphone which is smaller than a pack of cigarettes, and has the sensitivity of the finest broadcasting microphones.

One of the smallest broadcast microphones yet developed, the new low-cost RCA "Bantam" velocity microphone, is designed for use in radio studios, at remote broadcasts, at conventions, and in clubs. The unit is so small that it will not hide the face of singers, speakers, and others using it. It fits comfortably in the palm of the hnd and weighs only 12 ounces, making it ideal for use at remote pickups.

The diminutive size of this instrument is made possible by designing the magnetic structure as a part of the case. New highly efficient magnetic materials employed in te unit have also contributed to the reduction in size, while retaining an output level comparable to the larger, conventional types of microphones.

The built-in swivel which is part of the case allows the microphone to be tilted forward or backward through an angle of approximately 30 degrees. A switch located under the swivel pivot makes it possible to select bass response for voice or music. The voice position is useful for performers who must work close to the microphone, or in studios with long reverberation periods at the low frequencies.

During the early 1920's, telephone transmitters were used instead of microphones at pioneer broadcasting stations such as the one pictured here.

The bidirectional characteristics of the "mike" provide uniform frequency response between 80 and 8,000 cycles within a symmetrical figure eight pattern. It is shock-mounted and has low hum pickup as a result of special transformer design. A microphone of this type has been needed for a long time outside the radio industry, as most professional devices have been combersome and have detracted from the performer.

During the last war, much emphasis was made on a microphone that could take a beating, and low-cost carbobutton and crystal microphones were produced for the armed forces for communication equipment in planes, and on ships, as well as military bases. Also, the telephone hand receiving piece was modified and used on field telephones, but no real progress was made in the way of better reproduction of sound, as the microphones used in war did not beautify the voice, to any extent.

Today, there are different types of microphones manufactured for use of the public, as well as the broadcasting and recording industry, and with the development of the magnetic recorder (tape or wire), there is a great demand for low-cost, hi-fidelity microphones. Most of the professional "mikes" marketed today are priced in hundreds of dollars, and in most cases this would exceed the cost of the average home recording, or P.A. unit. Electro-voice has produced a relatively low-priced microphone called the "Slimair," which resembles the long, slim microphones used in television work today. The actual working unit is a dynamic type with a circular breath-screen, about an inch across enclosing it. The microphone is mounted in a tubular base, which can be held in the hand, or mounted on a stand. Microphones of this type are quite popular today, because of their compactness an dversatility.

The microphones used professionally and those representing the major principles involved in microphone construction, and thege neral uses to which microphones are put are described here.

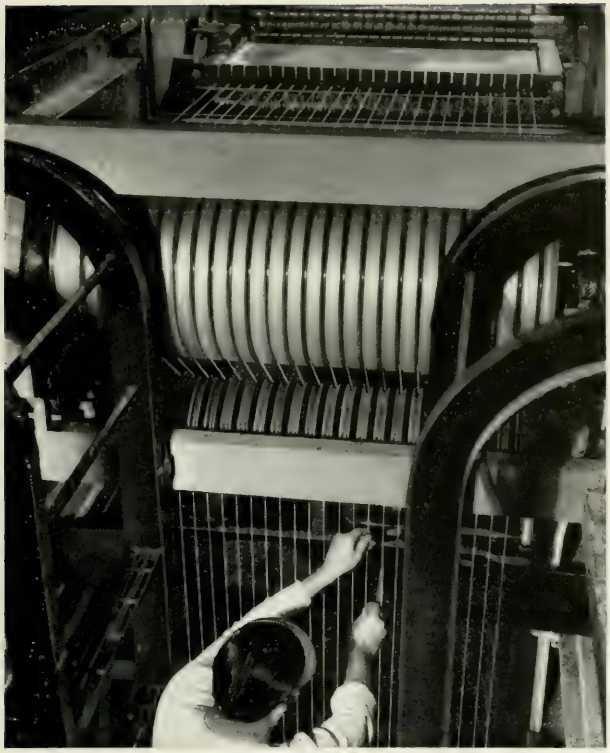
The RCA senior velocity microphone is intended primarily for studio use where a microphone of the highest quality of reproduction is desired. It can be used with practically any audio facilities system and is found in almost all of the leading studios in the country. The directional pattern is substantially a figure eight, thus making it bidirectional.

The Altec-Lansing M-11 is a nondirectional, high-fidelity, pencil-like microphone, useful for any situation where unobtrusiveness is desired. Attached to a flexible cable, it is especially handy when an "emcee" or announcer must move around, as in man-on-the-street and audience-participation shows.

A quite unusual microphone, resembling a walkie-talkie transmitting unit, is the BTP-1A radio microphone. It is a crystal-controlled portable UHF transmitter and microphone, especially adapted to broadcasts by announcers mingling with crowds on the street, at conventions, in large stores, at golf matches, or in other locations where wire connections or use of mobile transmitters is difficult or impractical. Its maximum satisfactory range is determined largely by the interference level at the receiver location. Under ideal conditions, several miles may be covered; however, building structures or other media possessing a high signal attenuation will limit the working range. Over-all transmitted quality is comparable to a network line.

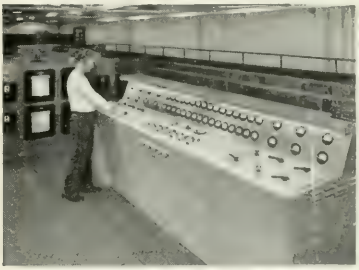
The RCA 88-A microphone is suitable for use in AM, FM, and TV studios for the following applications: (1) where concealment of the microphone is desirable; (2) where the artist must work extremely close to the microphone; (3) where audience participation requires use of a microphone which is rugged and may be handled readily; (4) where the announced must work very close to the microphone; (5) in newscasting and conference programs

(Continued on page 44)



25 strands of steel wire start on their way to be electrolytically coated with copper, lead and brass.

Part of the 600 foot long electroforming machines where wires go through successive baths of plating solutions.



Console of controls for entire process is readily operated when necessary, even though seldom used in the almost fully automatic operation

ENGINEERING . . . with a pioneering twist

There's a real incentive in working out ways to do things that have never been done before. And problems in pioneering are constantly cropping up at Western Electric—manufacturing unit of the Bell Telephone System.

For example: the revolutionary electroforming process dreamed up and made a reality by Western Electric engineers for making copper coated steel wire.

The big idea was this: Could a process be developed in which successive coats of copper, lead and brass would be deposited on steel wire electrolytically in one continuous operation?

Engineers of varied skills—electrical, mechanical, chemical, metallurgical, civil—went to work as a team. After solving many problems, they came up with a process that makes better, stronger wire at lower cost—does it at the rate of $1\frac{3}{4}$ billion feet per year.

Recent developments such as microwave radio relay networks for telephone calls and television programs—operator and customer dialing of long distance calls—secret electronic equipment for the Armed Forces—promise an ever-widening field for young engineers of varied training at Western Electric.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

ILLINI ARCHITECTS . . .

(Continued from page 11)

In 1911, there were twenty American architectural schools, and Illinois had 20.7 per cent of their combined enrollment of 1450.

It is obvious that the success of an educational program must be measured, not by size of enrollment, but by the impact and quality of its graduates. Under Ricker, the department produced a total of 315 graduates, 14 during the first decade, 29 in the second, 115 the third, and 157 the fourth. Of this group, 222, over 70 per cent, came from Illinois homes. Another 52, 16.5 per cent, came from states immediately adjoining, Illinois, while the school's growing reputation drew the remaining 13.5 per cent from all sections of the country. Of these 315 graduates, 273, an amazing 87 per cent, continued in some phase of architecture or building. 137, 43.5 per cent, entered the professional practice of architecture with their own offices. 68, half of these architects, have practiced in the State of Illinois, 14 returned to adjoining states, 14 went east, 7 south, and the building of the west drew 44. 35, 9 per cent, found careers as employees in architects' offices, 96, 30 per cent, became contractors, structural engineers, producers, or distributors of building materials, or worked in other phases of the buliding industry. 6 entered architectural education. Of the whole group, 49 per cent remained in Illinois for a major portion of their active life. It is interesting to note that in 1951 27 architects from these early graduates still held active licenses to practice in the State of Illinois.

Evaluation of quality of work resists statistical demonstration, but a number of these early Illini earned national reputations. To name only Charles Blackall in Boston, Arthur Peabody as State Architect of Wisconsin, Alfred Fellheimer of New York, Walter Burley Griffin, who in 1912 won the international competition for the Australian Capitol of Canberra, A. W. Archer of Kansas City, and John R. Fugard of Chicago, slights many others. Nor should those who only completed part of the curriculum be overlooked. In 1884, Henry Bacon, later the distinguished architect of the Lincoln Memorial, acquired here his only formal training. Some indication of professional standing is suggested in the fact that of the 137 practitioner-graduates, 40 per cent attained corporate membership in the American Institute of Architects. Six graduates of the early period won the coveted honor of election as Fellows of the Institute.

Since Ricker was so intimately responsible for the sound growth of the department, this extraordinary record of his graduates constitutes a very personal triumph. Not only did they display an enviable degree of professional competence and leadership, but they also contributed much to bring a more mature architecture to their own communities and the nation. With his retirement, the department entered upon a new era of development, but even today, after forty years have passed, his influence and example remain warm and challenging.

In 1910, Frederick M. Mann became head of the department. Three years later, in 1913, he resigned to establish a new curriculum at the University of Minnesota. His brief period at Illinois was marked by continued growth in enrollment and a reorientation of the teaching of design, to which he brought valuable experience gained at M.I.T. and the University of Pennsylvania.

In 1913, Loring H. Provine, an outstanding Illini architect of the Class of 1903 with a decade of top-flight field experience in new construction methods, was recalled to guide the department's future. His 35 years as head of the department was only two short of Ricker's term, and taken together they form a record of effective continuity unique in the annals of architectural education. Under Provine, the department successfully weathered three major academic emergencies caused by two world wars and the Great Depression. Enrollment fell from 364 in 1913 to 175 in 1918, rose to 495 in 1929, dropped to 230 in 1935 and 72 in 1944, and zoomed to 616 in 1947, not including 172 other architectural students taking freshman and sophomore courses at the university's new Navy Pier division in Chicago. The administrative problems posed by such exaggerated variations were handled with courage and skill.

Academic development likewise prospered. The disciplines of thoroughness and industry, for which Illinois graduates had become everywhere well-known, were carefully preserved. Cyrus Palmer and Newlin Morgan set an eminently high standard for instruction in structural design. Rexford Newcomb brought architectural history to vibrant life for a generation of students. Frank M. Lescher effectively expounded the principles of good construction. In architectural design, L. C. Dillenback and his assistants developed a program of participation in the Beaux-Arts Institute of design which produced brilliant results. In 1926 the department moved from Engineering Hall to its new building on the South Campus, and in 1931, the department, after sixty years association with the College of Engineering, was transferred to the newly created College of Fine and Applied Arts.

The department's growth in impact and service closely paralleled the expansion of the nation, state, and university. In contrast to the 315 graduates under Ricker, the period from 1912 through 1947 produced 1829, a sixfold increase. Approximately 85 percent of the department's students came from within the state, while the rest represented most of the states and many foreign countries. In 1951, 386 of these graduates were registered architects residing in Illinois, and they comprised exactly 25 per cent of all professional personnel within the state. 80 per cent of all graduates use their training directly in architecture or building, half of them in professional practice as employees in architectural offices, and half

(Continued on page 30)

Architectural design under Professor A. Richard Williams.

The University of Illinois at . . .

NAVY PIER

by Walter Olesky

"Should the University of Illinois Establish a 4-year Branch in Chicago?" was the subject discussed on the Forum of the Air radio program, Sunday, Dec. 14, over WIND in Chicago.

Participants in the panel discussion under Don Fedderson of Northwestern University, as moderator, were Senator Albert S. Smith of the 28th District of Decatur, Illinois, President H. C. Coffman of George Williams College, Chicago, and F. W. Trezise, Associate Dean, College of Engineering, University of Illinois, Chicago.

The last session of the Illinois State Legislature had already, by almost unanimous vote, approved the establishment of a branch of the University of Illinois in the Chicago area. This action was taken because of two centers of the population of this state. It was indicated in the discussion that one center is located near the present campus at Urbana-Champaign, and the other center of population is in the northeast area of the state, centered in the Chicago area.

Population in the Chicago area is at present about 52% of the total state. The large birth rates, which started soon after the early 30's, are now being felt in the secondary schools of the country, with the high schools overcrowded. This wave of increase in high school enrollment will reach the colleges and universities within a very few years. By 1960 it appears that the rate of high school graduations will be much larger than at present. It was noted to be almost a certainty that the capacity of the present campus of the University will be exceeded because of the increased birth rates. Plans to take care of this great influx into our colleges and universities were considered.

Dr. Coffman stated that with the present facilities, the privately endowed colleges of the State would find it impossible to take care of the increase with their present facilities. He also stated that he doubted very much that in any event they would be able to accommodate this large increase in enrollments.

The three participants then agreed that the State would find it necessary to increase its educational facilities to give the youth of the State the opportunity of college or university education.

The consistent growth of the Chicago Undergraduate Division of the University, since its establishment in 1946, was noted. The demand for an institution in the Chicago area has been voiced by leaders in the area, the students and parents, and various groups of services. Many have and are attending the Chicago Undergraduate Division, who would find it impossible to attain a university education otherwise.

A branch of the University of Illinois in Chicago could be established without plans for housing facilities—for staff or students—and the expenses would be much less than would be necessary in attendance at Urbana-Champaign, or at privately endowed institutions.

Also brought out in the discussion was the fact that Chicago is the only large metropolitan area in the country which does not have a publicly supported educational institution of higher learning.

Senator Smith noted that the type of college work which would be available here would be those courses in Liberal Arts and Engineering which the demand indicated. Dean Trezise then indicated that President Stoddard stated that 'if the State of Illinois, with its larger population, were to be compared with the State of Minnesota in their relationships to State university enrollments, the University of Illinois would have approximately 45,000 students. Since the administrative authorities consider that 20,000 students is the capacity of university facilities at Urbana, then a large branch from 10- to 15,000, at least, would be envisioned in the Chicago area.'

All three participants agreed that a branch of the University of Illinois would be feasible, and Dean Trezise stated that he thought that the privately endowed Liberal Arts' institutions have and still are performing a magnificent service to the country in their educational program and cultural facilities. Dean Trezise also stated that he hoped that this aspect of education, as contrasted with training, could permeate and become a part of the program of State institutions. This observation, together with that which Dean Tresize made, 'our first object in any educational program should be to encourage the finer aspects of good citizenship," drew comments regarding an "enlightened viewpoint coming from a college dean of engineering" from Dr. Coffman.

Senator Smith indicated that the proposed development in Chicago would cost from 50 million to 100 million dollars, and that it might involve a bond issue which would spread this capital investment over a period of years. He contended that this would result in no serious impact on the state resources. He was confident that the demand of the citizens of the metropolitan area insured a new campus in the Chicago area within a short time.

Interesting in the discussion was the acknowledgement of a rapidly-growing trend toward college education. That is why, it was stated, more students attend secondary schools, more students complete high school graduation, and a higher percentage of high school graduates attend college. It was noted that the trend is definitely toward post-high school education.

Other problems, it was agreed, such as the location of the new campus, might only be answered by the proper authorities, after making an appropriate study.

The coming session of the Legislature will be called upon to take definite action regarding the establishment of the Chicago branch of the University of Illinois, under House Bill 108.

The Dry Lab . . .

by Charles LaRobadier, M.E. '55
and Ray Andrews '56

HOW TO BE A BIG WHEEL

Maybe I ain't the smartest man in the world about some things, but when it comes to being a college man, watch out, cause I'm hot stuff. This here college social life is a snap, an being a hot thing round this here campi ain't nothing. Leave me tell ya all about howta do it an you too can be a hit with girls, like me.

Before you can show yer girl how well you are in social customs, you gotta geta girl. This can be a big problem, but if handled right, it is simple enough. Idea ista trap em 'for they geta good excuse notta go. A good type practice ista ask em what they're doin for they're wiseta whatcher upta. If you ask her for a date far nough in advance, she can't think an excuse, an you got her where you want her.

First off, you gotta be cool with the feminens an treat em right. None this "lightcher own cigarette" business. That mighta gone in high school, but this is college now. Take the match afer she lights it an then light her *butt*. She won't think yer sissy, in fact, women kinda go for that stuff. If the match should happenta burn your finger, don't let out with a long an tiresome stringa cuss words. A polite "Gawd Damn" is fine for any colledge girl, an the Oxferd accent will impress her muchly.

Next off, when you pour her Schlitz, careful notta spill none on her clothings. She will be peeved an might not be musch fun the rest of the night. This fancy yourin stuff is all fine nough with the boys, but less you're awful good, don't try it. You remember the good old sayin' "a beer in the doll is better than two on the floor."

Converz freely, but use yer common sense asta whatch talk about. Don't talk about sex too much or else ya might put her mind on her guard. As you must talk about somethin, talk bout the weather or rhetoric, maybe polotics if you're well versified in such type topics. Talk bout yer athletic feets if you feel qualified ta do so. Otherwise just hint at how popular you are around the university. Let her know she ain't the only pig in the pot. Some guys let their babes talk too much, an they think that these boys are stupes. Don't give a doll a chance if she tries to talk; cut her down with a sarcastic remark, or maybe step on her foot to kinda distract her a little. This'll keep her quiet an happy with such a good converser as you.

Last off, you gotta know whatta do on the wayta her house, an in the house also. This is important cause you don't wanna be a clubfoot then, or she will think you are not smooth as you have seemed to her earlier. A few hints to a happy ending are: Don't ever bump her inta the gutter when you walk with her, cause she might step in a puddle laying there; if the babe is more than 3 inches taller than you, don't try to put yer arm around her cause you might pull her off balance, an she won't like it too well; if she lives in a soreority house don't leave on the lights, cause she don't liketa let her pleges see her when she's doin things with you. A last word is when they say no, they really mean yes, cause with me, since I been usin this plan, I'm irresistible.

NAMED FOOTBALL CAPTAIN

Civil engineer Bob Lenzini '54 who drifted over to the south end of the campus and joined the football team was named captain on Monday, November 24, to replace the 1952 captain, Al Brosky.

Lenzini was introduced in the December, 1951, issue of the *Technograph* but has come a long way since that time, as every follower of the Fighting Illini knows.

Lenzini's amazing line play during the '52 Michigan game caused him to be named "Lineman of the Week" by national sports writers. The critics were almost unanimous in exclaiming, "Lenzini was superb."

Coupled with his prowess on the gridiron, is an engaging personality that has won him many friends both in engineering and elsewhere. Lenzini, in accepting the football captaincy, said "I hope I can carry on the tradition o all the fine Illini football captains. W have a lot of good freshmen this yea and I hope we can give you a winning season next year."

Lenzini's familiarity with footbal stems from his Waukegan High Schoo

BOB LENZINI

days where he actively participated i football and track. He graduated fron Waukegan in 1950 and entered Illinois He is enrolled in the civil engineerin construction option as a junior.

The *Technograph* wishes to take thi opportunity to congratulate Bob Len zini and to wish him well both i football and civil engineering.

NEWS FROM THE MISERABLES BRANCH

The University of Illinois branc at Miserables, Illinois, had the grea honor of having as a guest, Dean W. L Everitt of the home office. All of th stops were out in our attempt to enter tain him. In order to show him th town, permission was granted for hin to ride the milk wagon during its earl morning deliveries. In the afternoo he was asked to be the judge at a chick en cleaning contest at the local market And finally in the evening he was aske to deliver the principle address at meeting of the students and faculty i the "field house." The meeting wa delayed an hour due to the difficult of removing some of the stock.

In his address, Dean Everitt said "There are few earthly things mor splendid than a university. In thes days of broken frontiers and collapsin values when the dams are down an

(Continued on page 30)

How the Petroleum Industry Helped Solve the Nation's Benzene Shortage!

From these giant towers at Standard Oil's Whiting, Indiana refinery comes benzene, a product urgently needed by America's booming industries. The petroleum industry's hydroforming process is helping to solve the critical benzene shortage that threatened the nation.

HIGHLY-SKILLED chemists in well-equipped laboratories may come forth with anything from a new spray for protecting apples against disease and insects to a method for synthesizing benzene from crude oil fractions.

In the latter case, petroleum industry scientists had to run a race with a threatened critical shortage. Production of such things as synthetic rubber, nylon, styrene and phenol plastics, aniline dyes, sulfa drugs, insecticides and certain types of military explosives was endangered.

By use of the hydroforming process, which Standard Oil scientists helped to perfect, our technical men synthesized benzene from petroleum naphthas—and in large quantities.

In fact, at Standard Oil's Whiting, Indiana plant, benzene production capacity has risen in the past year to 16 million gallons. In addition, according to the Petroleum Administration for Defense, other refineries ultimately will produce many times this amount as the petroleum industry's answer to the chemical industry's urgent need for large additional quantities of this vital fluid.

Success in producing benzene commercially is only one of the many benefits derived from the petroleum industry's more than $130 million annual expenditure on research and technical services.

At Standard Oil alone 2,500 persons devote full time to research and engineering. Young college-trained technical men will find the wide variety of subjects under investigation and the keen competition in the petroleum industry stimulating to scientific thought.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD

THE DRY LAB . . .

(Continued from page 28)

the floods making misery, when every future looks somewhat grim and every ancient foothold has become something of a quagmire, wherever a university stands, it stands and shines; wherever it exists, the free minds of men urged on to full and fair inquiry, may still bring wisdom into human affairs." He then asked if there were any questions and M. Babet came up with the immortal inquiry, "How do you make a spot shot without scratching?" Dean Everitt replied that you should place the cue ball near the right rail and giving it forward english take the spotted ball to the left rail and thence to the right rear corner pocket. He pointed out that he had worked his way through college with this shot. This was followed by a thunderous ovation and numerous handshakes by officials of the branch. Then President Madeleine reported that since the branch was unable to pay honoratums to outside speakers, that Dean Everitt would be presented with several gifts. The first was a lovely foot-operated bottle capper. It was pointed out that since the Republicans are again in power this piece of furniture probably would again become the most useful in the house. Also, he was given a rubber stamp with his name, address, and salary, to be used on his personal mail. Dean Everitt, in tears over these magnificent gestures of friendship, stated that the rubber stamp alone would improve the ratio of sent to received Christmas cards.

HISTORY OF ENGINEERING

So old is the profession of engineering that its beginning remains untraced. Even when we go to the very first of the earliest accurate historical records we find extraordinary feats of engineering which have already been standing for centuries. Although much progress has been made by archeologists recently, we must still speculate as to how the pyramids of Egypt, for instance, were constructed. Neither can it be surely said how the Grand Canal of China, a waterway 700 miles long, with 75 locks, and 3,000 years old, was built; or the prehistoric draining of Lake Copaias by a tunnel 4 miles long, and in places 150 feet deep; or the great monuments of stonehenge, the Egyptian obelisks, the findings made in Peru, and Mexico, the Euphrates tunnel which is probably 4,000 years old and numerous other examples. All these are remaining examples that witness not only the tremendous scale on which prehistoric engineering was practiced, but also the incredible ingenuity which remains baffling in the light of our modern knowledge of applied science.

The pyramids were completed in spite of the fact that the ancient engineer could enlist only the crudest of cutting tools, wooden sledges, ropes, the lever and the inclined plane. Yet the accomplishments have endured from his day to ours through all the growth of our civilization.

Man first distinguished himself as a higher being through the use of tools which he fashioned into implements and weapons to satisfy his primitive hunger. Yet even before that he built temples for worship, tombs for the dead and shelter for himself and his family. The Stonehenge temple, the dolmens, the lake dwellings of Switzerland, are brilliant examples of primitive constructive instinct. The imagination of the stone-age man worked on a large scale. The dream of the men who conceived the idea of the Brooklyn Bridge, the Eiffel Tower, or the Empire State Building was nothing in magnitude to the conceit of the sun-worshipper who planned one of the early monuments of the stone age, because the necessary resources were infinitely less. He was forced to work with stone tools while the modern engineer uses pneumatic hammers and drills; the ancient engineer commanded man-power alone, while we have steam and electricity.

The stones for the Great Pyramid were quarried a hundred miles up the Nile, carried on barges down the river and pulled over land on sledges. It is guessed that the stones were lifted into place by ropes, aided by earth ramps, rockers, levers and rollers. The crude boulders were shaped and finished with stone mauls. And yet it stands 481 feet high, covers 13 acres of ground and contains 85 million cubic feet of stone.

We are more familiar with the Greek and Roman achievements through accurate historical records; the aqueducts, some of which are still intact; fortresses, roads (many of which are the bases of the present national highways of France), engines of war, Caesar's famous bridge across the Rhine, and many others which are still studied and respected as examples of great skill and workmanship.

The important yield from this study is not technical information, however, as much as is the sense of value of the engineering profession given to a man about to become an engineer. It is something of an inspiration to realize that it is one of the oldest, most dignified, and most vitally important of all professions, as well as an expression of one of the fundamental human instincts.

In spite of its ancient achievements, engineering is still in its infancy. The railroad, the use of steel, steam power, electricity, the internal-combustion engine, the airplane, and now, atomic

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ILLINI ARCHITECTS . . .

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in other sections of the building industry.

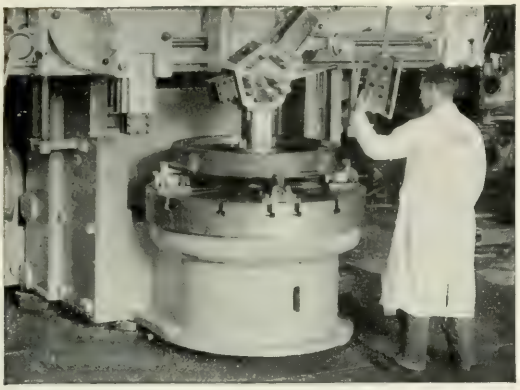
In 1950 the American Institute of Architects conducted a major survey of the 19,137 registered architects in the United States. The survey revealed that 75 per cent of these architects had attended a professional school, and that 56 per cent had obtained their undergraduate, or first, professional degree. Furthermore, of all undergraduate degrees conferred, 9.9 per cent had been awarded by the University of Illinois. This also means that Illinois graduates comprise over 5.9 per cent of the architectural profession in the United States. The three next highest schools were responsible for 4.24, 3.44, and 3.01 per cent respectively. The breadth and depth of the university's influence in the nation's architecture is thus solidly demonstrated.

During the past five years, firm effort has been made to hold fast to the great traditions which eighty years of devoted and enlightened work have built. At the same time, this tradition itself calls for continued adjustment to new conditions. The dynamic quality of architecture and education, based as they are upon human need and action, impose an obligation and opportunity to plan the direction of future growth. One of these years was devoted to inventory and analysis of the educational program and its expansion to a five-year curriculum. Another was occupied by review and modification of the component courses. A third investigated, with the close cooperation of the profession, the teaching of architectural design for contemporary practice. After long deliberations, the result was DESIGN FOR PRACTICE, a new and challengeging method which incorporates, however, many time-tested principles and devices. D-F-P is now in its second year, and, despite the anticipated need for evolutionary refinements, it is fulfilling its promise in excellent fashion. During the current year, much time is being given to the exciting problems of the appropriate objectives, methods, and content for graduate studies in architecture, which may well prove to be the most fruitful avenue for future development.

There are some who doubt that high quality of results can accompany large enrollments, and that any school that continues to care for 9 per cent of all U.S. architectural students, as Illinois has done for the past several years, defeats its own aims. Such critics forget that quality is not a function of size. Indeed, a large school often enjoys many positive aids to quality by its

(Continued on page 56)

Another page for **YOUR BEARING NOTEBOOK**

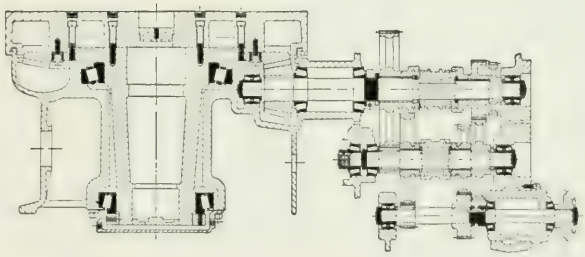


How to keep a high speed boring mill accurate

To insure table accuracy in high speed boring mills, spindle vibration must be eliminated. That's why designers mount the table spindles on Timken® precision tapered roller bearings. They hold spindles in positive alignment, eliminate vibration. Line contact between rollers and races of Timken bearings provides extra load-carrying capacity. The true rolling motion and incredibly smooth surface finish of Timken bearings practically eliminate friction and wear within the bearing itself.

How spindle and drive shafts are mounted on TIMKEN® bearings

The drive of a high speed boring mill is mounted on single row type TS, and two row type TNA bearings. Input, intermediate and bevel pinion shafts are mounted on two type TS bearings on one end, and a two row type TNA bearing free to float on the opposite end. Single row type TS bearings are indirectly mounted on the main table vertical spindle.



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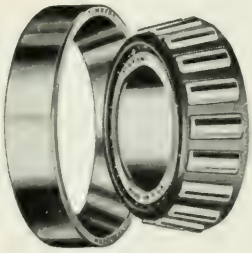


Want to learn more about bearings?

Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. Clip this page for future reference, and for a copy of the 270-page General Information Manual on Timken bearings, write today to The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST —◎— LOADS OR ANY COMBINATION ✳

Structure . . .

by Dave Cohn, E.E. '55

Mr. Frank J. Kornacker, an important structural engineer and consulting architect from Chicago is a member of the architectural staff of the University of Illinois. Here at Illinois he teaches Advanced Analysis of Building Structures to graduate architecture students. He has been here since February 1952, and at that time he took over Professor Link's classes.

Mr. Kornacker was born in Budapest, Hungary and came to the United States in 1914. He attended high school in Chicago, and went on to graduate from Illinois Institute of Technology in 1926 where he received a B.S. in Civil Engineering. Shortly after his graduation, he worked for Smith and Brown, structural engineers. Later on he came back to I.I.T. to give a series of lectures on building structures. Mr. Kornacker was associated with a number of large engineering firms in Chicago until 1938. He then became the Chief Draftsman for the Municipal Engineering Department of Milwaukee, for two years.

Following the outbreak of World War II, Mr. Kornacker became a consulting engineer for the Navy at Pearl Harbor in 1941. When rebuilding at Pearl Harbor was completed, he became associated with Greeley and Hansen, hydraulic and sanitary engineers. He remained with them until 1945, when he opened his own office as a consulting engineer.

Mr. Kornacker leads a busy life, commuting to school here, and operating his own office in Chicago, aside from having a wife and three boys to take care of. He is a member of the Western Society of Architects, American Concrete Institute, and Chi Epsilon, honorary Civil Engineering fraternity.

He has designed many buildings, most of them in Chicago. The most well-known of them today is probably the 860 Apartments, at 860 Lake Shore Drive. Mr. Kornacker worked in collaboration with Ludwig Mies van der Rohe and PACE Associates, in designing the structure. The 860 is a pair of 26 story steel and glass towers standing near the shore of Lake Michigan. The structure is black painted steel and the wall is glass from floor to ceiling, all the way up. Total construction cost was about $4,404,000 or approximately $10.38 per square foot. The buildings were partially constructed by means of prefabrication. All vertical wall sections were pre-assembled and welded on the roof, and then dangled down into place. This was done in several stages. The floors are concrete slabs poured on prefab corrugated steel sheeting. The buildings have a two story basement used for a garage to house the occupants cars. Heavy water pressures were encountered, because of the great depths of excavation, so that the entire sub-basement floor was anchored to the piles which supported the entire building. Another complication that came up was the presence of an old, abandoned water tunnel beneath the construction area. It had to be mapped out with pin-point accuracy so that the pilings could be driven around its edge. The buildings are of all-steel structure, and possess a number of features used for the first time in Chicago. The buildings use radiant heating systems using space between the bottom

(Continued on page 52)

860 Lake Shore Drive, one of Professor Kornacker's structural projects, viewed at night from the west side. (Photo by Hedrich-Blessing)

Design . . .

by Tom Madden, Gen. E. '54

Seldon has a man engaged in widespread work with such striking achievement as has A. M. Richardson, now a professor of architecture here at the University of Illinois.

Trans-World Airlines ticket office in Chicago designed in 1948 by Professor Richardson. (Photo by Vories Fisher)

Now only 36 years old, he was born in Helena, Arkansas, and lived in the South until 1930, when he moved to Chicago, attending high school there at Hyde Park. Richardson attended the University of Chicago and I. I. T. (Armour Institute), graduating in 1939 with a B.S. in architecture. His first employment was as designer for the architect-engineer firm of Skidmore, Owings, and Merrill during the years 1937 through 1941. When the axis powers threatened the freedom of the world from 1942 through 1945, Richardson saw service in England, Africa, Corsica, and Italy with the U. S. Army Air Force. He served in the Engineering Office of a Tactical Medium Bomb Squadron.

After the war, A. M. Richardson again took up his duties with the firm of Skidmore, Owings, and Merrill, this time as senior designer. In 1947, he became chief of design for the firm, serving in that capacity for the company when it undertook the massive Oak Ridge permanent housing and schools project in the years 1948 and 1949. Following the Oak Ridge project he was designer for the New York Life Insurance project, "Lake Meadows," in Chicago.

In 1951, Richardson took up his duties as a professor of architecture at the University of Illinois.

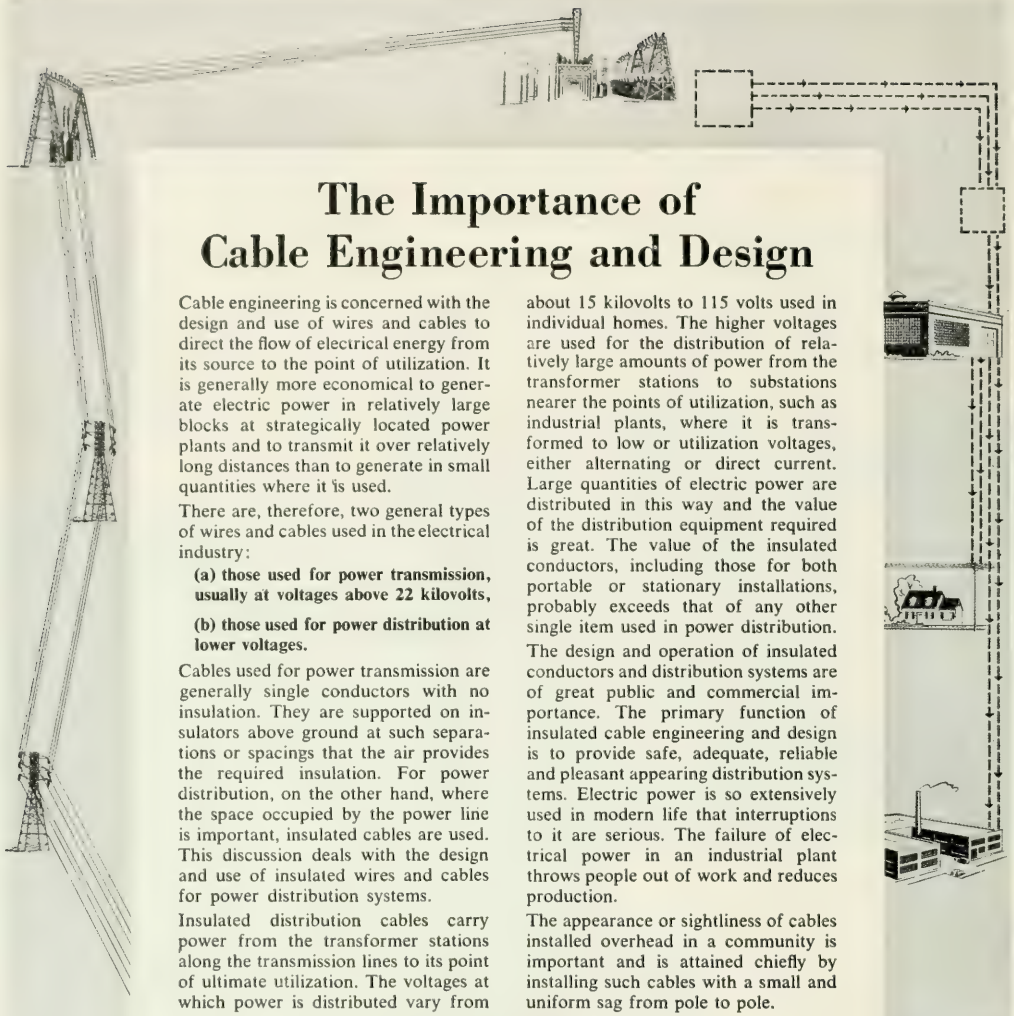
Like most architects, he has his own feelings and ideas on the subject of architecture. The following thoughts by Professor Richardson express what he calls *The New Architecture*:

"Architecture has always been a product of its time. So it is now. The influences in our intricate society have created an architecture of vastly different concept than ever before known, yet it essentially remains sculptured space and form."

"Architecture was never more important than it is today. The architect today is boldly attempting to create an orderly building scene in spite of the innumerable chaotic tropisms influencing him. To do this he must be an objective innovator, a comprehensive designer. He must be able to orient himself in his society, to possess an innate sense of values and a broad background of cultural and material fact."

"The new architecture should be an architecture of intelligence, not of whim. Buildings are not trifles or amusing expressions for the architect or owner. Every building is a public trust in its absorption of natural environment subjected to the concern of everyone for generations to come. Each building must relate to its time and its environment." *(Continued on page 48)*

Garden Apartments at the Oak Ridge, Tennessee, permanent housing project designed by Professor Richardson while he was chief designer of the project for Skidmore, Owings, and Merrill. (Photo by Torkel Korling)



The Importance of Cable Engineering and Design

Cable engineering is concerned with the design and use of wires and cables to direct the flow of electrical energy from its source to the point of utilization. It is generally more economical to generate electric power in relatively large blocks at strategically located power plants and to transmit it over relatively long distances than to generate in small quantities where it is used.

There are, therefore, two general types of wires and cables used in the electrical industry:

(a) those used for power transmission, usually at voltages above 22 kilovolts,

(b) those used for power distribution at lower voltages.

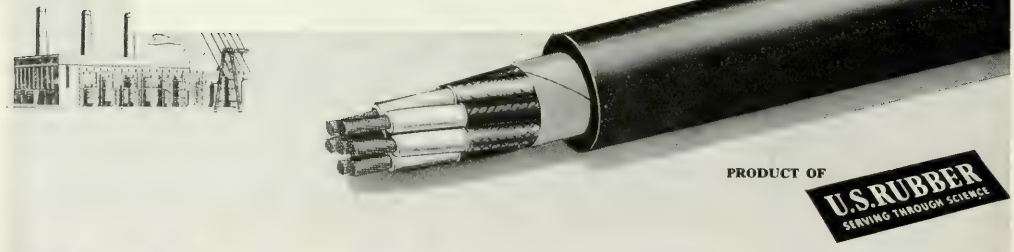
Cables used for power transmission are generally single conductors with no insulation. They are supported on insulators above ground at such separations or spacings that the air provides the required insulation. For power distribution, on the other hand, where the space occupied by the power line is important, insulated cables are used. This discussion deals with the design and use of insulated wires and cables for power distribution systems.

Insulated distribution cables carry power from the transformer stations along the transmission lines to its point of ultimate utilization. The voltages at which power is distributed vary from about 15 kilovolts to 115 volts used in individual homes. The higher voltages are used for the distribution of relatively large amounts of power from the transformer stations to substations nearer the points of utilization, such as industrial plants, where it is transformed to low or utilization voltages, either alternating or direct current. Large quantities of electric power are distributed in this way and the value of the distribution equipment required is great. The value of the insulated conductors, including those for both portable or stationary installations, probably exceeds that of any other single item used in power distribution.

The design and operation of insulated conductors and distribution systems are of great public and commercial importance. The primary function of insulated cable engineering and design is to provide safe, adequate, reliable and pleasant appearing distribution systems. Electric power is so extensively used in modern life that interruptions to it are serious. The failure of electrical power in an industrial plant throws people out of work and reduces production.

The appearance or sightliness of cables installed overhead in a community is important and is attained chiefly by installing such cables with a small and uniform sag from pole to pole.

Watch for the appearance of the second advertisement in this series in a forthcoming issue. Reprints of this advertisement and subsequent ones, relating to the uses of insulated wire and cable, will be sent on request without obligation.



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Skimming Industrial Headlines . . .

by Maurice Garnholz, Aero. Eng. '56

Resistant Building

Activities usually found separately in research laboratories, office buildings, hospitals, printing plants, educational centers, and even in television studios are combined together under one roof in the Armed Forces Institute of Pathology Building now under construction in Washington, D. C. Further complicating the design was the requirement that the main portion of the building be blast resistant.

The architects solved blast resistance to a great extent by making most of the structure windowless. To give flexibility in the laboratories, to save on costs, and at the same time to assist in blast resistance, they placed the laboratories back-to-back in the center of the building divided by a service core and bounded by corridors, with offices and other functional areas adjacent to exterior walls. This two-corridor plan furnishes a building of considerable depth — highly desirable for resisting bomb blasts.

Reinforced concrete walls are included in certain places in the interior to help resist the pressure. All but one of the openings in the blast walls are taken care of by specially designed blast doors.

Lighting was designed mainly to provide an adequate quantity of light, while not putting an excessive load on the air conditioning, and to give good color discrimination.

New Aerial Weapon

North American Aviation, Inc., has disclosed that just over the horizon is a new aerial weapon labled as the greatest argument for an all-out effort to establish world peace. The new weapon is referred to as "the true intercontinental guided missile which some day will be a reality." It is a weapon which will be capable of accurately delivering to any point on the surface of the earth in a few hours a warhead carrying infinite destruction, and which because of its speed and altitude will be impossible to intercept.

It is pointed out that technical problems make it impossible to predict how soon this weapon will be available, for the aircraft industry "is going through a technical hell" because of the fast-moving advances in the aeronautical sciences.

Among engineering headaches are listed the synthesis of reactions which utilize just about every field of physical science and a few which haven't been invented yet, and the heat barrier at which many known materials lose enough of their strength at very high speeds to be impractical for future airframe structures.

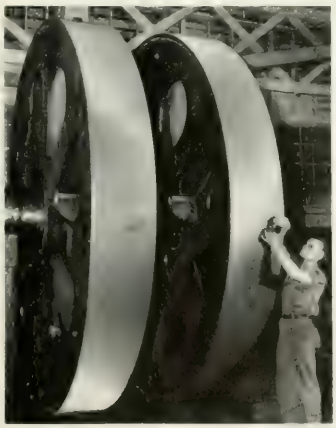
Powerful Propulsion Equipment

The most powerful propulsion equipment ever to be used on a warship will be supplied by the General Electric Company for the new U. S. Navy aircraft carrier CVA-60.

The equipment, consists of four cross compound turbines with the greatest economy ever realized on a large naval ship.

With the same amount of fuel, the new type equipment will enable the giant carrier to travel approximately 20 percent farther than it could with World War II type equipment. The greater economy results from higher temperatures and pressures in the steam turbines.

Although propelling a ship more than a city block long, the propulsion equipment will occupy no more space than a small corner lot. The ship is scheduled for completion in 1955.



This monstrous gear weighs twenty-one tons and will be used to drive the propellor of a large ship.

Glass "Blackboards"

Glass crayon boards now being made by the New York Silicate Book Slate Co. are especially designed for use with the manufacturer's water soluble wax crayons. Together the products are reported to solve the problems of stain and dust commonly associated with the employment of colored chalks. The crayon marks can be easily erased with a moist cloth, sponge, or tissue, since the wax base dissolves instantly when in contact with water. Available in red, blue, violet, green, brown, and black colors, the hexagonal shape of the crayons suits them for marking in fine and broad lines, as well as shading.

The boards are made of plate glass with a vitreous enamel surface and can be obtained in light green, buff, or ivory. Despite the high reflectivity of the colors, the flat surface of the boards is said to minimize glare.

Stiffness Tester

A sensitive instrument which rapidly and conveniently measures the stiffness of commercial papers has been developed by the National Bureau of Standards. In the new device, the specimen is bent through a given angle, and its stiffness is measured by the torque in a wire suspension. By varying the width and length of the specimen and the angle through which it is bent, and by using supporting wires of different sizes, instruments of this type could be employed to test papers having a wide range of stiffness. The NBS Stiffness Tester is also expected to prove useful in evaluating the stiffness of thin plastic sheet, textiles, and similar materials.

In many paper products — such as paper towels, currency, and playing cards — stiffness is one of the most important criteria of usefullness. The stiffness of wrappers and containers is an important consideration in the use of automatic packaging machinesry. Stiffness is also a factor in the "feel" and "rattle" by which the quality of many papers is judged. In the past, a number

of methods have been proposed for determining the stiffness of paper and similar materials. Most of these methods, however, evaluated paper stiffness empirically and in a relative manner by measuring such arbitrary quantities as the force required to bend a strip of given size through a certain angle or to deflect the end of the strip a given amount. The tester was developed to meet the need for a sensitive method which would give consistent values of stiffness independent of specimen dimensions and angle of bending within a usefully wide range.

Electroluminescence Explored

Electroluminescence, the illumination exhibited by a phosphor-coated flat glass panel when subjected to an electromagnetic field, is being explored for the Westinghouse Lamp Division by the two top scientists in the field — Prof. George Destriau and Dr. Joseph Mattler.

The two men began exploring the phenomenon in 1935, more than ten years before American lighting engineers suspected its possible commercial uses. In this country, they have been testing a new superior phosphor. The experiments have been reported to have been most valuable in learning more about the lighting qualities of phosphors. As a commercial lighting source, electroluminescence is still just a possibility. Under ordinary conditions, it produces only a small amount of light at very low efficiencies.

Aluminum Al

Science has not yet discovered how to grow hair on a billiard ball, but General Electric chemists can grow a handsome head of white "hair" or a beard on "Aluminum Al," a sheet of pure aluminum cut out in the shape of a man's head.

Actually, "Al's" hair is aluminum oxide, which forms in a moist atmosphere after the metal has been scratched while held under mercury.

Amusing as he is, "Al's" purpose is a serious one of helping provide a better understanding of the most effective ways of using aluminum, which is replacing copper in many critical applications.

Aluminum is very active and could not be used were it not obliging enough to furnish its own protective coating, a thin film of aluminum oxide, which forms immediately over a freshly-cut surface exposed to air. The film keeps air away and prevents further oxidation.

"Al" demonstrates a condition under which this does not occur. When the aluminum surface is scratched under mercury, the film does not form. Instead, the oxide sprouts out along the scratches in an uncontrolled hairlike growth.

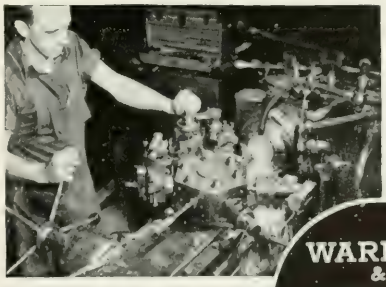
Somebody ought to speak sharply to Nature

THERE's a lot of loose talk these days about profits, attacking them as though they were evil.

The very existence of the world depends on profits; the *improvement* of the world depends on *big* profits. A farmer plants one potato and usually gets back 15. Even allowing for all his costs, that's more than 1000% profit! He plants one pound of corn and gets back 336 pounds—that's 33,600% profit. These are big profits. Is that bad?

Should the farmer be scorned as anti-social? Should his "excess" profit (whatever that is) be taken away from him? Should he be told that from now on he must limit his "profit" to, say, 6%?

To legislate against profits is as silly as to legislate against things growing.



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CITY OF TOMORROW . . .

(Continued from page 13)

ways looking for better ways to make the shell—and it occurred to me, thinking in terms of very light structure, to make a shell that would cover the whole town, use gas to support it, and then everything within the town would be completely flexible."

The more Richardson thought about the idea, the better he liked it. He admits it started as a dream, and even yet it has some dream-like qualities around the edges, but as he proceeds with plans and discussion he becomes more convinced that the idea is feasible. Of course, he would start in a small way, with a little dome, and work up to the big, or economy-size dome which would cover a whole town.

Getting down to the physical facts, the dome would, as originally conceived, be made of plastic. Just what kind of plastic is the subject of current research.

"We probably will make some trial runs on both plexiglass and Vinylite," he said. "It will take a lot of experimenting, of course, to find the ideal material."

The canopy would be composed of triangular units. Each unit would be roughly three feet to a side, but the triangles would not all be uniform in shape. At the top they would be equilateral, but as the canopy spread the triangle would, of necessity, change shape to accommodate themselves to the curve of the dome.

One of the next questions, of course, would be that of how the units would be held together. Richardson had thought of fusing them, and it may be that in time, when all our towns are domed, that will be the method. But for experimental purposes, he is going to try lacing them together through eyelets on flanges which will edge each triangle.

The triangles will be inflated with helium, and probably be selfsealing. Only enough gas, in the aggregate, will be used to lift the canopy, without creating any pull. That way it can be easily anchored without danger of its pulling up stakes and floating off like a runaway balloon.

The dome will be built from the top and center out to the edges. As it was completed, the gas would lift it into the air. By the time it was finished it would have more or less placed itself in position, assuming work was started at the geographic center of the town.

The dome would rise to a height of a mile or so in the center and come down to within 10 or 12 feet of the ground at the periphery. Af course, the height of the dome would be determined somewhat by the circumference, which in turn would be determined by the area to be covered.

There would be a hole in the top center of the dome to allow for circulation of air. It, in turn, would be protected by a platform roof, only slightly larger than the hole, and open all around, something like the cover on a chimney.

The dome would let in the sun's light and heat, while filtering out undesirable rays, and stopping things like rain and snow. The snow, incidentally, presents something of a problem, one which Richardson hasn't gotten around to coping with yet. The rain would, of course, all run off the edges, but it wouldn't be wasted. It would be captured in reservoirs, like the rain caught on the roofs of Bermuda, and saved for whatever use anyone wanted to put it.

Which leads the train of thought, naturally, into aesthetic channels. It is gratifying to note that the professor has not been incognizant of poetic values.

"I know," he laughs, "there are people who are going to bring up the pleasures of listening to the patter of rain on the roof, not to mention the poets who write about the wind and the rain in their hair. Well, we might have to make out without rain on the roof, but anyone who wants to make like Garbo and walk in the rain can always get out from under the dome."

As for water to make lawns and shrubs and flowers grow, the rain water which runs off the dome would be back, and everyone would have an automatic lawn sprinkling system. The chief advantage here would be the elimination of wasted water. Millions of gallons of rain water which ordinarily run off into the sewers and eventually to the ocean could be impounded and used as needed. During a drouth like last summer's, for instance, lawns could be kept green and fresh.

A dome with a hole in the top creates a down draft which would assure people of plenty of fresh air. The higher the top of the dome, the cooler would be the air. This down draft would drive the old air out at the periphery, insuring constant circulation of fresh air. In the winter the sun's rays would warm the air, but the dome would keep out the cold winds.

People would fairly blossom with health, Richardson is convinced. With controlled temperatures, respiratory ailments would be reduced to a minimum. The air would be cleaner and consequently less germ laden. There would be no smoke — all industrial plants would have to be outside the dome—and consequently no smog.

(Continued on page 48)

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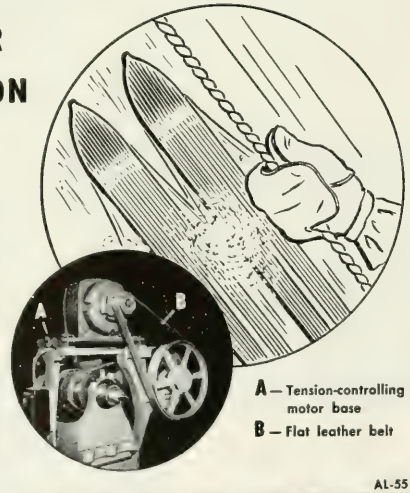

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ARCHITECTURAL HISTORY . . .

(Continued from page 9)

A fourth objective is the development of a sense of professional tradition and continuity through knowledge of the aims and accomplishments of distinguished predecessors. Physicians still incorporate the Hippocratic oath in their medical code of ethics. From some knowledge of the medical achievements of Avicenna, Versalius, and others, they derive inspiration and an awareness of their professional heritage. So from study of the architectural achievements of Ictinus, Pierre de Montereau, Michelangelo, and Wren, the embryonic architect develops a sense of belonging to a great professional tradition, a tradition rich in its service to mankind.

At the University of Illinois the courses in History of Architecture are organized to constitute a methodical chronological survey stretching from antiquity to the present. This is only one of several possible methods of procedure, but it seems the one best suited to the aims of the courses in the opinion of the present staff.

Located in a business-residential neighborhood, the River Grove office of the Illinois Bell Telephone Company is an example of the planned building that has regard for its surroundings. (Courtesy of Illinois Bell)

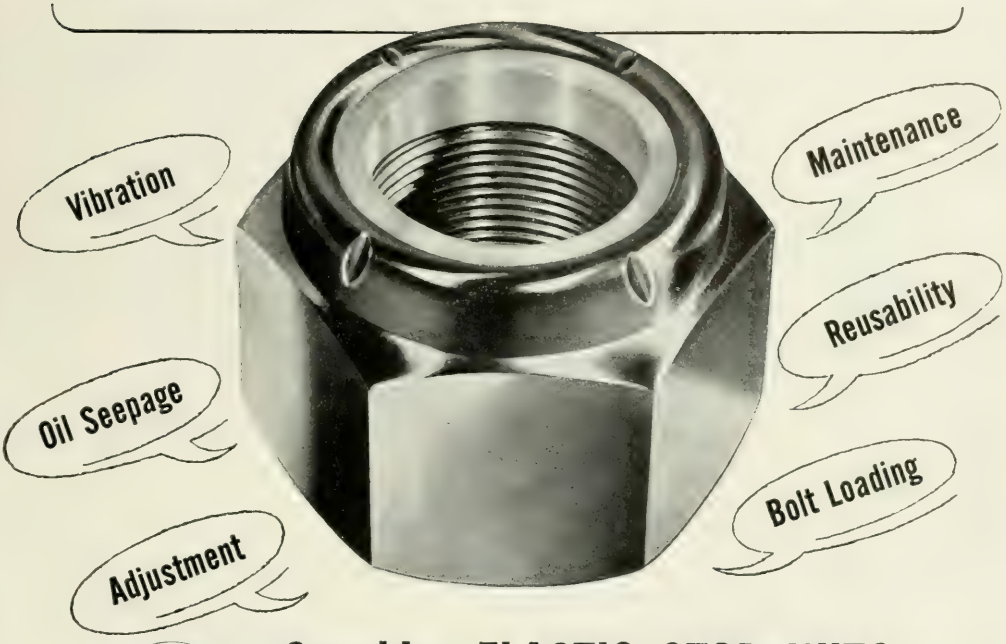
An interior view of the north cell block at the Illinois State Penitentiary, Pontiac. This is an example of the clean functional form that modern architectural design may take. (Photo by Herbert George Studio)

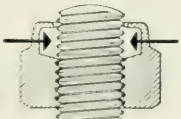
The undergraduate courses number four. They begin in the second half of thet sophomore year and continue through the first half of the upper junior (i.e. fourth) year. The first deals chiefly with the architecture of Egypt, West Asia, Greece, and Rome, or from the beginning of social history to the time of Constantine; the second with the medieval period or the architecture of the Early Christians and Byzantine civilization, that of the Early Moslems and that of Europe during the Romanesque and Gothic eras; the third with the Renaissance, Mannerist and Baroque periods in Europe and the Americas; the fourth with the architecture of the nineteenth and twentieth centuries in Europe and America.

Throughout the courses, emphasis is upon the lessons to be derived from the past and not upon styles of architecture *per se* or upon the use of these styles for the present-day conditions. We have learned that the architecture of a people, like its music, its art, its literature, must grow out of the aspirations of the people and the specific conditions of the environment. We cannot force the functions of the present into the architectural shells of another age without architectural and economic sacrifices. We now perceive that behind the colorful nineteenth century "battle of the styles" two high significant systems of construction evolved—both in Chicago. We see in this same century the advent of a professional organization, the American Institute of Architects, and the consequent lessening of some of the hazards of com-

(Continued on page 60)

Whenever fastening problems arise...





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THE MICROPHONE . . .

(Continued from page 22)

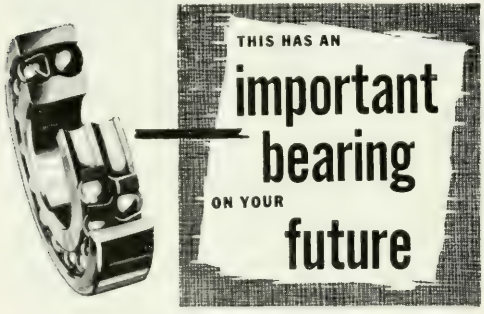
where each participant has a microphone; (6) in broadcast and television remotes; (7) on programs and announcements on remotes where a rugged microphone is required which will not be boomy when worked close; (8) in sportcasting where a light rugged microphone is required; (9) in out-of-door remotes of all kinds where the microphone will be subjected to weather; (10) for news events where small microphones will not hide speaker; (11) on interview programs where a lightweight microphone facilitates quick and easy handling.

The RCA 77-D high-fidelity microphone provides a choice of directional pattern in AM, FM, and TV studios. As a *bidirectional* microphone, it can be used in place of the 44-BX with some loss of high frequency response. As a unidirection microphone, the 77-D may be used to advantage in the following applications: (1) on general programs and studio announcements; (2) on television booms—the required amount of microphone movement is reduced, the pick-up of unwanted sound back of the microphone is reduced, and the working distance to the microphone is increased; (3) where it is desirable to cover a large area with a single microphone; (4) where studio acoustics are more live than optimum; (5) where it is desirable to eliminate audience noise originating behind the microphone; (6) where the directional pattern permits orientation to eliminate undesirable reflections; (7) where the announcer must work close to the microphone; (8) on general programs and announcing in remote locations; (9) for plays, stage presentations, banquets, news events where it is desirable to reduce the pick-up of sound behind the microphone; (10) where the directional properties will help to reduce the effects of an overly reverberant location. As a *non-directional* microphone, the following applications are suggested: (1) for announcing in studios and remotes where the announced must work close to the microphone; (2) on out-of-door programs where the microphone need only be protected against rain. The 77-D is extremely versatile, and experience has shown that its characteristics may be adjusted to cover almost any pick-up condition.

The MI-6206-G offers outstanding performance as a public address microphone. Its relatively wide frequency response, high sensitivity, and attractive appearance also readily adapt it for use as a "talk-back" microphone in broadcast studios. It is well suited to the requirements of a program director's microphone, or it may be used for emergency announcements.

The MI-6204-C microphone is of new design, as compared with other RCA varacoustics which it resembles. A slide adjustment which changes the physical characteristics of the labyrinth permits a choice of nondirectional, bidirectional, or unidirectional operation. In addition, three variations between the unidirectional and bidirectional pattern may be obtained. The varacoustic microphone is suitable for public address use under high reverberatory conditions and for stage pick-ups where auditorium noises are to be kept to a minimum. As an economy microphone it may also be used for similar broadcast applications when shock mounting is not required.

The main "trunk" of microphone development already has been explored. There are many branches, however, which have not figured extensively in broadcast applications. True, progress has not always been direct but there have been surprisingly few retrogressions. The objective of microphone design has always been to meet the conditions established by usage. So far there has been a satisfactory solution for every problem presented.



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RICHARDSON . . .

(Continued from page 33)

"The new architecture should reflect the appropriate use of material and structural method. It should fuse the basic concept of scheme with the statement of building purpose. It should incorruptibly attempt to reduce the complex building formulas to simplest terms."

"It will serve the basic shelter needs for man's biological, emotional, and constructive functions, but at the same time it must recognize the inevitably changing needs within the shelter. It will recognize that man and nature will remain constant but all other factors are variable."

"The new architecture must be beautiful. It will complement nature, man, and the artificial environment. And this beauty will not come in the false traditional emotional concept of beauty incurred by erroneous concepts of style and the quest for spurious prestige. It will be a beauty of order, a natural beauty with every element in its proper place, properly related to every other element and the whole assemblage, which is an integrated complement expressing the fundamental idea and purpose of the structure."

"In short, the new architecture will be a natural manifestation of demands and intelligent answers to those demands."

"As man constantly attempts through science to answer the riddles of nature,

PROF. RICHARDSON

so will architecture attempt to find nature's principles of structure and orderly beauty. In so doing he will create an exciting new world in which to live."

While in school, Richardson was awarded several prizes and awards among which were the Spiering Prize (National Junior Prize) and First Award—Ryerson Traveling Scholarship competition. He was also elected to Scarab architectural fraternity and Tau Beta Pi. After school he won the Chicago Tribune competition (3 years) and National Mention in NAHB house competition, 1950.

Professor Richardson, who is married and has three children, has visited during his work and study, England, France, Italy, French Morocco, Algeria, Tunisia, Egypt, Palestine, Corsica, Denmark, Sweden, and Holland. the *Tech* salutes Professor Ambrose M. Richardson for his work in the past, and wishes him the best of luck in his future endeavors in the field of architecture.

CITY OF TOMORROW . . .

(Continued from page 38)

Life under a dome would eventually result, as a matter of course, in something entirely different in the way of houses, Richardson believes. Without rain or snow or even a heavy dew, we would have no need of roofs. The only reason for walls would be for privacy.

"That's the trend in architecture anyway," Richardson points out. "Buildings must adjust themselves to their uses. Hospitals and schools built 25 years ago are already obsolete. Take schools, for example. Their design was based around the idea of the class room where students sit in rows of desks and face a teacher. But with audio-education, and TV education coming along, there is no more reason for the school to follow the same pattern than there was for the first automobiles to follow the pattern of the buggy. The same is true of the home."

Of course there are some problems which haven't been solved yet, Richardson is quick to admit. Problems such as how to de-ice the dome in case it freezes, and what to do about snow piling up.

Right now, Richardson is seeking someone to finance his experiments. He is thinking of appealing to the plastic manufacturers, and he may invite the American and National Baseball Leagues to get in. Because he plans to start out with small domes that would cover, say, a baseball park, and he points out that it wouldn't take many rained-out Sunday games to pay for a $100,000 dome. Further, they could play ball the year around if they wanted to.

Richardson and his students will conduct their first experiments on the campus, with a dome that will cover about an acre. From that they can learn a lot about the problems to be overcome. They will go on to bigger and better domes, and who knows, some day you may live under one. Your grandfather laughed at Edison.

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KORNACKER . . .

(Continued from page 32)

of the floor and the top of the ceiling below it, forming a plenum chamber, through which the heat is emitted. The structural steel used weighs 11.2 pounds per square foot, which is very light compared to ordinary structural steel which varies from 20-25 pounds per square foot. The use of this special steel and fireproof vermiculite plaster for the walls, reduces greatly the weight of the entire structure.

Working with the architectural firm of Keck and Keck, Mr. Kornacker designed the Prairie Courts at 26th and Prairie, for the Chicago Housing Authority. They are composed of one 14-story building, and three 7-story buildings. No bricks are used in the construction except along the windows. Walls of the buildings are of exposed concrete and flat slab construction. The 14 story building involved special wind-bracing problems, which were solved by reducing the thickness of the concrete slab floors, as the height of the building increased. The structure is of reinforced concrete with clear glass between columns. Borings made before construction showed that a high compressible layer of peaty clay was present in the sub-strata, making it necessary to drive tremendous piles, each capable of a capacity of 50 tons, down to bed rock. Occurrence of peaty clay in Chicago is caused by many underground springs, which are a product of Ice Age, and make construction of tall buildings very difficult.

Another CHA project Mr. Kornacker designed is the Harrison Courts, at Harrison and Francisco, on which he worked with PACE Associates.

Another engineering feat accomplished by Mr. Kornacker was the construction of the Lunt-Lake Apartments, the tallest, reinforced brick buildings in the world. The sister apartments to Lunt-Lake are the Winchester-Hood Garden Apartments, which are of the same construction, but not as tall. Structures of reinforced concrete seem to be the coming trend in apartment construction.

A building recently erected with the help of Mr. Kornacker is the College of Dentistry and Pharmacy located at the University of Illinois Medical Center in Chicago. It is a 6 story structure housing laboratories, clinic rooms, a huge auditorium, and lecture halls. An important structural feature are the 56 foot long clear spans for construction of labs without interferring beams or supporting columns. The top structure is strengthened with 200 foot trusses. Welded vierendeel trusses in the roof and attic floor add to the supporting strength. The outside of the buildings is finished in brick with modern functional design.

One of the first of the really, modern partments to be built in Chicago is the Promontory Apartments at 5530 South Shore Drive. Built in 1947, it was the first tall apartment building to be erected since the 1930's. This impressive structure, designed by Mr. Kornacker is composed of reinforced concrete with 21 stories. The cement used in the structure is of air-entraining type to improve durability in exposed concrete. The building has radiant heating with pan-joist construction in the ceilings. This building was the first of its type to be worked by Mies van der Rohe.

A drunk was leaning against a building. A cop growled, "Move on, move on. What do you think your'e doing—holding up that building?"

The drunk staggered away and the building fell down on the cop.

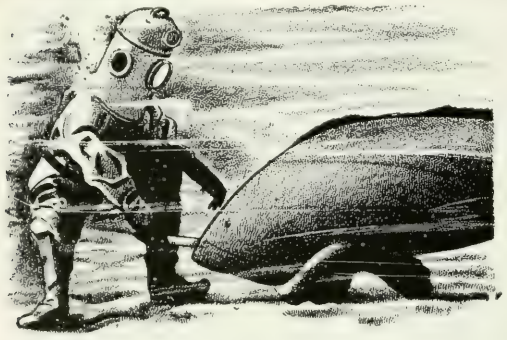
* * *

An infant was awakened from a peaceful slumber in a hospital. Looking down at his raiment, he yelled over to the occupant of the next crib:

"Did you spill water on my diapers?"

"Naw."

"Humm. Musta been an inside job."



The wonders of the ocean's floor are duplicated in two giant tanks at Marine Studios, at Marineland, Fla. More than 30,000 live undersea specimens are presented in their natural setting, and into these tanks are pumped more than 7,000,000 gallons of sea water per day.

Okolite-Okoprene cable was selected as the most reliable means of supplying power to the motors which pump this water. Power is taken from a 2300-volt circuit and stepped down to 220-110 volts, for motors ranging from ¼ to 30 h.p.

The corrosive influence of salt water and salt air has virtually no effect on the tough Okoprene sheath which protects Okolite-Okoprene cable.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE *insulated wires and cables*

8785

A new contribution to accuracy and production *from Brown & Sharpe;* for measuring bores or holes directly — without masters, reads like a conventional micrometer. Eliminates many expensive plugs and setting rings. Sixteen sizes to measure from .275" to 4.000". Extensions are available to facilitate measuring deep holes. Write for illustrated Bulletin. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

BROWN & SHARPE

What Are They?

- ☐ *Thrust bearings*
- ☐ *Clutch disks*
- ☐ *Grinding wheels*
- ☐ *Ceramic insulators*

The correct answer is grinding wheels, shown as they emerge from the electric kiln.

Not ordinary grinding wheels, however. They are Norton *New-Process* Wheels — made by modern, streamlined, precision methods developed by Norton engineers.

A Big Step Forward

This new process involves advanced equipment, new manufacturing techniques, and close quality control during every step of grinding wheel production. As a result, Norton *New-Process* Wheels are produced to a degree of structural uniformity never before possible.

This increased uniformity means extra assurance of consistent grinding action throughout each wheel and from wheel to wheel. Which, in turn, means more evenly wearing, longer lasting wheels — together with more cutting action per wheel and per dollar.

In addition, the built-in balance of Norton *New-Process* Wheels cuts down vibration and enables them to hug the work more closely, assuring smoother, better grinding performance.

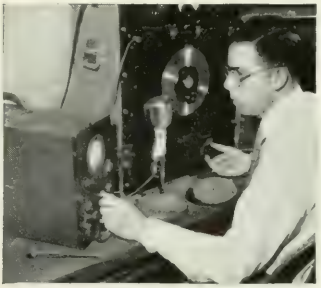
A wide range of wheels employing both ALUNDUM* (aluminum oxide) and CRYSTOLON* (silicon carbide) abrasives are made by the new process.

Looking Ahead With Norton

Geared to industry's constantly expanding needs, Norton Company serves *every* manufacturing field by "making better products to make other products better." Young men planning technical careers are invited to consider the established leadership and far-ranging scope of the Norton world-wide organization.

Send For Additional New-Process Facts

Recent Norton literature gives further details on this important advancement in grinding wheel manufacture and performance. Write for your free copy.



John J. Amero, M. S., Cer. Eng., North Carolina State '38, checks duplication of grinding wheel grade with the aid of an oscillograph. John has been working on the development of Norton "New Process" wheels.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

NORTON

TRADE MARK REG. U. S. PAT. OFF.

Making better products to make other products better

ABRASIVES · GRINDING WHEELS · OILSTONES · ABRASIVE PAPER & CLOTH · REFRACTORIES, POROUS MEDIUMS & LABORATORY WARE · NON-SLIP FLOORING · GRINDING & LAPPING MACHINES · BORON CARBIDE PRODUCTS

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

BEHR-MANNING TROY, N. Y. IS A DIVISION OF NORTON COMPANY

ILLINI ARCHITECTS . . .

(Continued from page 30)

ability to provide more diverse and more specialized facilities. Then, too, such critics overlook the fact that a growing nation demands an expanding profession, which in turn requires the training of enough personnel to supply the essential services it needs. The solution consists, therefore, not in reducing all schools to comfortable intimacy, but in assuring an optimal quantity and quality of instruction. It is apparent that the people of Illinois require, for their own physical well-being and for the education of those of their youths who respond to the challenge of architecture, a professional school of architecture whose size and excellence is commensurate with their need and destiny. This is the only proper goal towards which the Department of Architecture of the University of Illinois should strive.

Voter: "Why, I wouldn't vote for you if you were St. Peter himself."

Candidate: "If I were St. Peter, you couldn't vote for me—you wouldn't be in my district."

* * *

She: "Only a mother could love a face like yours."

He: "I'm about to inherit a fortune."

She: "I'm about to become a mother."

THE DRY LAB . . .

(Continued from page 30)

power, all still remain to be perfected. Each new invention opens another field of study.

The vast, almost untapped resources of Siberia, China and Korea are a challenge to the mining engineer. South America not only has many undeveloped resources for mining, but cries for development of all types of communication. The condition of world commerce is in proportion to the use made of resources and the United States is being depended upon to supply not only the capital needed but also the men who have the skill and knowledge so vital to success in handling the situation.

Reconstruction of wartime devastation demands engineers of all kinds. Manufacturing is necessarily increasing constantly. New industries must be devised in some cases to save battered countries from disaster. All this means new demands on engineering not only for an increase in engineers but also an output of new ideas which must constantly be improved.

At once the oldest and the youngest profession, engineering is limited only by the laws of nature on which research is constantly being done, unceasingly disclosing new realms of work for the originality and imagination of the engineer.

A farmer and a professor were sharing a seat on a train. It was getting lonesome so the farmer started a conversation and they soon became a friendly pair.

"Let's have a game of riddles to pass the time," said the professor. "If I have a riddle that you can't guess you give me one dollar or vice versa."

"All right," replied the farmer, "but since you are better educated than I am, do you mind if I only give you fifty cents?"

"OK," replied the professor, "You go first."

"Well, what animal has three legs walking and two legs flying?"

"I don't know. Here's your dollar. What's the answer?"

"I don't know either. Here's your fifty cents," replied the farmer.

Crossword Answer

■	F	L	E	M	I	N	G	■	F	I	E	L	D	■
F	O	O	L	■	D	E	E	■	E	N	T	E	R	■
O	R	B	■	P	O	W	E	R	■	T	O	R	Y	■
U	T	■	O	I	L	S	■	O	P	E	N	■	■	■
C	■	A	W	E	S	■	A	G	A	R	■	S	R	■
A	U	G	E	R	■	F	U	E	L	■	R	I	O	■
U	S	E	S	■	H	U	N	T	■	P	I	L	E	■
L	E	D	■	C	A	S	T	■	B	A	C	O	N	■
T	R	■	M	A	T	E	■	B	A	R	E	■	T	■
■	■	C	O	R	E	■	P	O	L	E	■	C	G	■
B	O	H	R	■	S	H	A	R	E	■	H	O	E	■
E	R	A	S	E	■	E	R	A	■	M	A	I	N	■
D	E	T	E	R	■	M	A	X	W	E	L	L	■	■

Another COMMUNITY REFRIGERATION CENTER Developed with Frick Refrigeration

Entrance to Quick-freezers

In 1927 the Carthage (Missouri) Ice & Cold Storage Company was operating a 30-ton ice tank.

Today the modernized plant makes 110 tons of ice per day; has a dozen city and country routes, ices railway cars and trucks; rents 2,800 lockers; freezes up to 200,000 pounds of eggs, poultry, strawberries, boysenberries, and packing house products daily; operates 600,000 cubic feet of freezers and coolers. The office is air conditioned.

All the cooling loads are carried by ten large Frick refrigerating machines.

Another example of a prosperous COMMUNITY REFRIGERATION CENTER developed with Frick Refrigeration.

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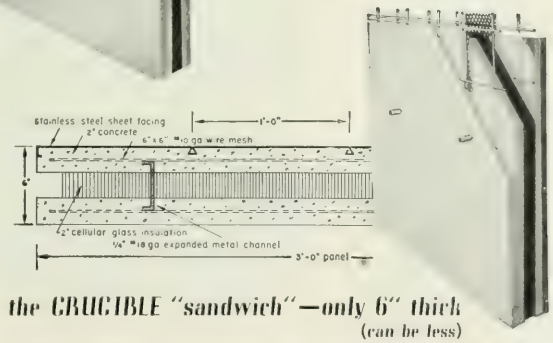
What's Happening at CRUCIBLE

about stainless curtain walls

Modern construction methods have changed walls from the self-supporting type to a mere covering which does not support its own weight for more than one or two stories. Hence the definition of "curtain wall":—the facing or enclosure of the structural steel frame. This frame supports the entire weight of modern buildings.

The need has existed for a covering that would not only clothe the building, but be lightweight, economical and space saving. Because these requirements are more than adequately met with stainless steel curtain wall construction, this method is being increasingly popular with cost and space conscious owners, builders and architects.

the CRUCIBLE "sandwich"



the CRUCIBLE "sandwich"—only 6" thick

(can be less)

Crucible stainless steel curtain wall panels are in the form of 6-inch thick "sandwiches". The facing consists of flanged, light-gauge stainless steel sheets with a factory, or site-fabricated, sandwich consisting of cellular glass insulation between two layers of concrete with connecting reinforcing. Crucible 18-8 stainless as the outside face offers excellent resistance to weather and fire while providing eternal beauty with a minimum of maintenance; the inside face can be finished or painted to suit the requirements of modern building interiors. Since 18-8 is restricted in use, a good substitute material, type 430 stainless, now government decontrolled, offers the same benefits as 18-8 stainless.

moisture penetration

The unique characteristics of the cellular glass insulation stop moisture vapor migration from one face of the panel to the other. The cellular insulation properly designed and installed assures that condensation will not take place *anywhere* within the sandwich.

insulation

Although less than half as thick as the usual wall construction, this Crucible stainless steel panel construction has more than twice the insulating value. The "U" value (overall thermal conductivity) is approximately 0.15 BTU Hr./Sq.Ft./°F.

fire resistance

The Crucible sandwich met the requirements of a standard 4-hour fire test conducted in the testing laboratories of the National Bureau of Standards. This meets all old building codes and is double, or better, the requirements of modern enlightened building codes.

erection and fabrication

Since a building frame is not precision built, the attachment of the panel walls to the frame is done with fastening devices that provide necessary 3-dimensional adjustment. Panels can be made at the building site, and a 24-hour casting-to-fastening cycle is possible.

technical service available

Though the use of some stainless steel is now restricted, Crucible metallurgists and development personnel are continuing to investigate improved methods of curtain wall and other construction so that better buildings can be built when stainless is more freely available. For more information write: Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Penna.

CRUCIBLE first name in special purpose steels

52 years of Fine steelmaking

Midland Works, Midland, Pa. • Spaulding Works, Harrison, N. J. • Park Works, Pittsburgh, Pa. • Spring Works, Pittsburgh, Pa.
National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

ARCHITECTURAL HISTORY . . .

(Continued from page 42)

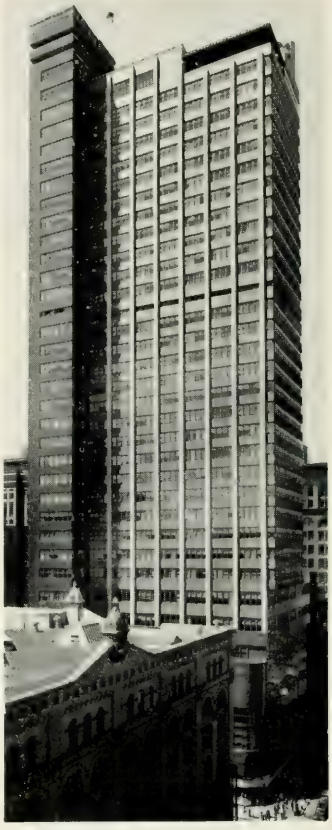
petitive jungle existence. These and other aspects of nineteenth and twentieth century architecture have resulted in an increased allocation of time to these periods.

As classes range from forty to ninety in size, the illustrated lecture method is used. Most of the slides shown on the screen are in black and white, although colored slides are being added or substituted as rapidly as good ones become available and acquisition funds permit. The slide collection of the Ricker library includes art and architecture and now numbers about 27,000. The photographic collection is almost as large.

In the final course in History of Architecture, the students are required to follow independent research on some topic of their own choosing and write an extensive illustrated report. These are known as the Ricker Reports, in honor of Dr. Nathan Clifford Ricker, the first Head of the Department of Architecture at the University of Illinois. Recent titles among the Ricker Reports include: "A Study in Space Composition" (F. L. Wright and Le

(Continued on Page 63)

The north cell block of the Illinois State Penitentiary, an example of maximum security institutional design that possesses confining strength, yet is pleasing to view. (Photo by Herbert George Studio)



A bank and office building combined, the Philadelphia Savings Fund Society building. The form of the structure was in a large degree determined by the needs of those using the building.

Bearing Torture Chamber of a World Champion
Through this spur gear box, a record-breaking speedboat, SLO-MO-SHUN, set a world's straightaway record of 160.3 mph for a mile. Although the straightaway runs were made with a damaged drive shaft, the 3 to 1 step-up ratio in the gear box turned the output (propeller) shaft 11,100 r.p.m. The tandem duplex bearing took a thrust load of 4600 pounds. 5 Fafnir Super-Precision Ball Bearings are used in the gear box . . . another indication that the use of Fafnir Bearings is not limited to one or two industries but is industry-wide. The Fafnir Bearing Company, New Britain, Conn.
Facts about Fafnir
To assure uniformly high standards of quality in Fafnir Ball Bearings nearly one-fourth of Fafnir's employee force is assigned to inspection operations.
FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

860 LAKE SHORE . . .

(Continued from page 19)

and bath. However, I do not think that the floor plans of these apartments are the most ideal that could have been used. In all cases, there is either a bath or the kitchen immediately next to the entrance. This is a situation that could have been avoided, and I believe should have been.

The atmosphere and open feeling of the apartments is very good, and the success of this is attested to by the fact that almost everyone would like to live in 860 if they had the chance.

The stirring facts about 860 is that it was built for a very sober price. PACE Associates, who were collaborators in design and construction, report the construction cost per sq. foot at $10.38. They point out that this is 5 to 10% below most conventional apartment house costs in Chicago. The total construction cost was $4,404,000 and this included a swollen sum of $430,000 for very difficult foundation work, and $87,000 for drapes and their hardware. The same material, a blend of orlon and acetate, was hung in all apartments, with a second curtain track provided inside the first for the owner's individual hangings if they want them.

In this, the first use of "a tower of glass" for living, the expected number of wrinkles have had to be ironed out in occupancy. Most of the criticism of the apartments, however, has come from people who do not live in them, a not unprecedented pattern in the short but acriminious history of Modern Architecture.

Apartments in 860 have proven to be remarkably good buys. Originally the three-and-a-half-room co-ops sold for $6,500, and the six-room units for $12,000. But their resale price today, only a year after the project was occupied is, by attested sales, $11,000 for the small apartments and $21,000 for the large. The north tower of three-and-a-half-room apartments actually contains 19 six-room units—doubles which were thrown togther by people who could not obtain the six-room apartments they wanted.

The overall success of 860 is the success of a new conception of design by Mies van der Rohe, and a new precedent in engineering skill by PACE Associates. It is a proven financial success to its backer, it is popularly an aesthetic success, and last, and most important, it is a functional success.

"Whenever I get down in the dumps," said the first girl, "I always buy a new hat."

"Oh, so that explains it," said the other, sweetly. "I've often wondered where you got them."

ARCHITECTURAL HISTORY . . .

(Continued from page 60)

Corbusier), "The Globe Play House," "The Arkansas Territorial Capitol," "Two Planned Towns: Riverside and Zion, Illinois," "The Modern Industrial Village of Kohler, Wisconsin," and "The Merveille of Mont San Michel."

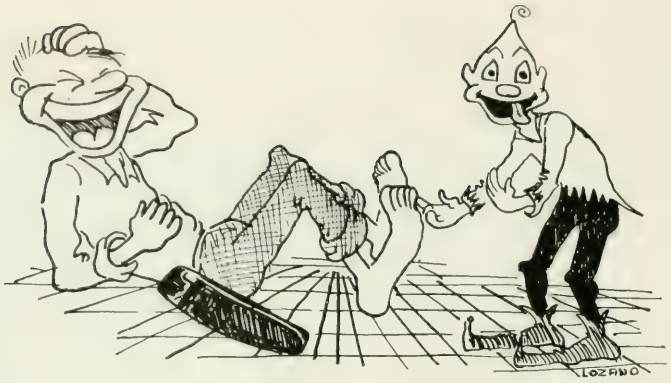
Three prizes are awarded in this competition by the local chapter of Alpha Rho Chi. These take the form of a Gold Key which uses as the central part of its design an exact replica of an ancient Mycenaean sculptured seal dated prior to 1450 B.C.

For a number of years, Mr. Robert Allerton, the generous donor of Allerton Park, has made possible two traveling scholarships, known as the Allerton American Traveling Scholarships, for the study of Early American Architecture in New England. These have been awarded annually to two junior students in junior History of Architecture whose scholarship and promise of success have been outstanding. The scholarship holders follow a planned itinerary and submit a report on their travel and study. These reports frequently become works of art in themselves. Copies of the twenty Allerton Reports and of the winning Ricker Reports are shelved in the Ricker library. Recent winners of the Allerton Scvholarships were: Tom Klausmeyer and Al McHenry in 1950-51; John Messner and Tevis Freeman in 1951-52. Like previous scholarship holders, they returned from their summers of historical exploration with a maturity of architectural judgment and a heightened enthusiasm for their chosen profession.

She: "How would you like to have mother for lunch?"

He: "No thanks, my digestion isn't what it used to be."

A detailed view of the construction of exterior walls and window divisions of 860 Lake Shore Drive.



TECHNOCRACKS

A college professor had checked out of the hotel and before getting more than a few blocks away realized that he had left his umbrella. Returning to the hotel and approaching the room he had just vacated, he learned that a newly-wed couple had just taken the room.

They were in that baby-talking stage, and as the professor peeked through the keyhole, he saw the groom kiss the bride and heard him say:

"Whose 'ittle mouth is that?"

"Yours, darling," she assured him.

"And whose 'ittle hands?" he asked kissing them.

"Yours of course, dearest," she replied.

"Listen here young fellow," called the professor impatiently through the transom, "when you come to the umbrella, it's mine."

* * *

Prof: "I believe you missed my class yesterday."

Student: "Why, no, I didn't. Not in the least."

* * *

Professor of economics: "You engineers of today want to make too much money. Why, do you know what I was getting when I got married?"

Bright ME: "No, and I'll bet you didn't either."

* * *

Missionary: "Poor man. You know nothing of religion."

Cannibal: "Oh yes I do. I got a taste of it when the last missionary was here."

* * *

E.E.: "I like mathematics when it isn't over my head."

C.E.: "That's the way I feel about sea gulls."

The lunatic who, after a very exemplary record of sanity was discharged from the asylum, was returned home, and on the following morning decided to shave as every man does. He nailed the mirror to the wall, stood before it, lathered his face, proceeded to shave; at this moment the nail slipped and the mirror fell to the floor. He stood gazing at the blank wall before him, then remarked bitterly; "Just my luck, second day out, and I've cut my blooming head off."

* * *

I think that I shall never see
A girl refuse a meal that's free;
A girl with hungry eyes not fixed
Upon the drink that's being mixed;
A girl who doesn't like to wear
A lot of junk to match her hair;
But girls are loved by guys like me
'Cause I don't like to kiss a tree.

* * *

"Doing anything Saturday night?"
"Nope."
"Could I use your soap?"

* * *

She: "I don't like that sailor, he sings too many dirty songs."
He: "Does he sing them to you?"
She: "No, he whistles them."

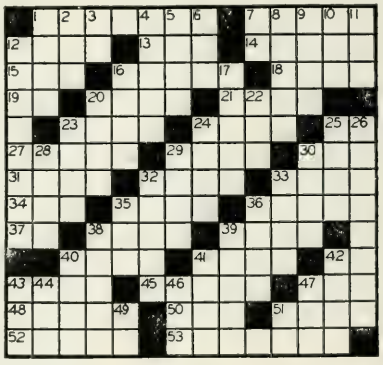
* * *

A university is an institution which has room for 2,000 in its classrooms and 50,000 in its stadium.

* * *

First drunk: "Shay, know what time it is?"
Second: "Yeah."
First: "Thankish."

Crossword Puzzle



ACROSS

1. Inventor of the "valve detector" used in radio
7. Inventor of the distance telegraph box
12. Simpleton
13. British river
14. Go within
15. Sphere
16. Electricity, a convenient form of this
18. Extreme conservative
19. Old musical note
20. Lubricates
21. Not allowing current to flow, as a switch
23. Inspires with reverential fear
24. Gelatin from seaweed
25. Elder: abbr.
27. Drilling tool
29. Furnace food
30. Spanish river
31. Consumes
32. English experimenter with the action of light
33. Early form of electric battery
34. Guided
35. Shaped by being poured into a mould
36. "The father of scientific research"
37. Transformer: abbr.
38. Ship's second in command
39. Not insulated, as wire
40. Center of a solenoid
41. Support for overhead wires
42. Ten milligrams; abbr.
43. Danish scientist, devised our present idea of atomic structure
45. Blade of a plow
47. Garden tool
48. Expunge
50. Epoch
51. Chief; most important
52. Hold back
53. Proponent of the electromagnetic theory of light

DOWN

1. Armed stronghold
2. Tennis stroke
3. Overhead railroad: colloq.
4. Objects of adoration
5. Information
6. Turn to the right
7. Iron: chem. symbol
8. Bury
9. Famous English school
10. Ancient British sea-god
11. Type of electric cell
12. Discoverer of "eddy currents"
16. Wharf
17. 19th century writer on magnetism, etc.
20. Is indebted to
22. Chum
23. Old
24. Uncle's wife
25. Storage place for fodder
26. Discoverer of X-rays
28. Consumer
29. Device protecting a circuit from overloads
30. Popular oriental food
32. Dislikes violently
33. Peel
35. Elevator cage
36. Large bundle
38. American artist and telegraph inventor
39. Common flux for soldering
40. Informal talk
41. Best grade of rubber
42. Solenoid
43. Foundation for a dynamo
44. Scandinavian coin
46. Sewed edge of a garment
47. Diminutive of Henry
49. Expression of hesitation
51. The one speaking

(*Answer on Page 56*)

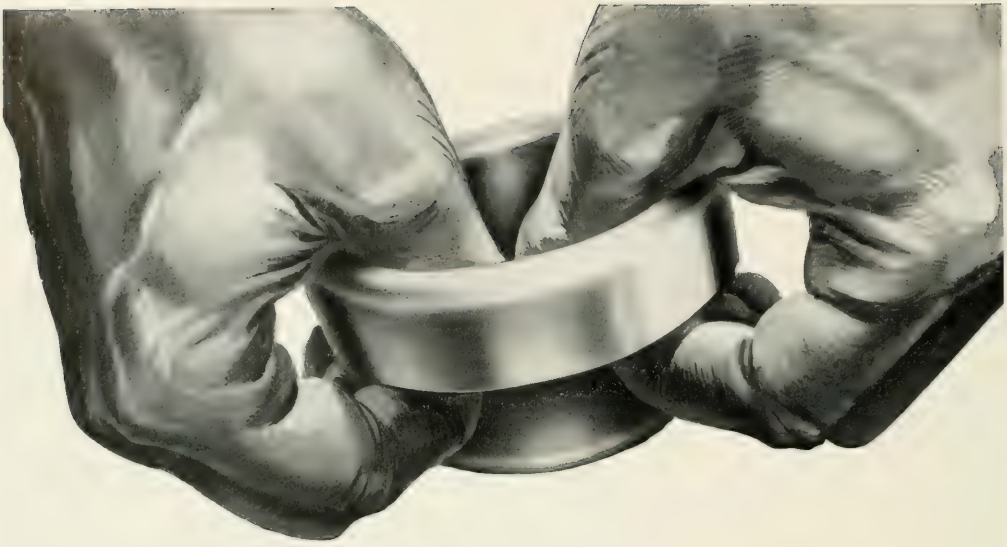
Chemistry Library
Noyes Laboratory
Urbana, Ill.

ILLINOIS TECHNOGRAPH

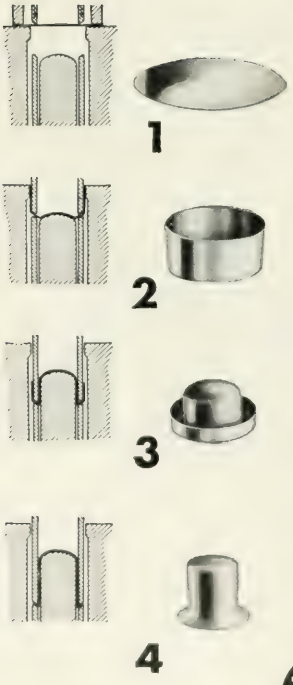
PREVIEW OF YOUR ENGINEERING FUTURE

OPEN HOUSE ISSUE!

MARCH, 1953 .25



How to turn a high strength steel cup inside out, cold



OFFHAND, anyone familiar with high strength steels would say it couldn't be done. But one of our customers does it every day.

Employing a unique reverse-drawing method and using a U·S·S High Strength Steel especially adapted for this process, they turn out cylindrical containers of various kinds that are not only stronger than those made from carbon steel but weigh substantially less.

To accomplish this, the steel has to meet two entirely opposite requirements. It has to be so strong that it can be used in thinner gages to reduce weight, and yet must have enough ductility to satisfy the drastic fabrication method that would be considered severe even for carbon steel.

This method is used to draw cups for large, low-pressure cylinders. These cups, 14½ in. in diameter and 24½ in. deep, are drawn cold, from 12-gage steel blanks in one continuous stroke in a reverse draw press. The diagrams at left show how it is done.

Starting with a 38 in. diameter steel blank (Fig. 1) the press first draws the steel into a shallow cup (Fig. 2). As the stroke continues, the cup is literally *turned inside out* (Fig. 3) to form the finished cup (Fig. 4) which has very uniform wall thickness. Two of these cups are then welded together to make a cylinder.

Made with high strength steel, cylinders weigh about 20 lbs. less. The maker gets 26% more cylinders from each ton of steel used. Lighter weight makes cylinders easier to handle, and also pays off in lower freight costs—both on the steel from our mills and on cylinders shipped. (A customer 500 miles away saves as much as $100 per carload.)

Developing special steels for special customer needs is an important job of United States Steel metallurgists and engineers. With their tremendous background of practical experience, they are ready to work on any problem that involves the more efficient use of steel. United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

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UNITED STATES STEEL

An Engineer . . .

You know what the duties of most professions entail. The doctors and lawyers are immediately associated, in your mind's eye, with the functions they perform. It's amazing, however, how many people are in error as to what an engineer actually does. The word "engineer," to many, calls to mind a grease smudged laborer who carries a monkey wrench around in his hand. It's true that in the past, many pioneers in the engineering field carried their tools with them—and even to a little oil at times, but this is a misconception of an engineer. Another fallacious image people assume to be real, is the automaton engineer who sits at the drafting board and manipulates his T-square and triangle eight hours a day. Just as mistaken are those who picture the man who repairs their radios or television sets. There is a vast difference between the mechanical maintenance and repair functions of the service expert and the experienced analysis and solution of problems by the engineer.

In other colleges of the university, the engineer is chronically misunderstood as an "uncultured, specialized, and introverted" product of an engineering education. The absurdity of this all-too-prominent opinion is obvious when we view the present situation.

Despite all these conceptions and misconceptions concerning the engineer, he is rapidly coming into his own and assuming his essential position in our economy. Both the mighty industries which he has created and the civic and social life to which he feels a great responsibility are dependent upon the engineer. Since so few people actually realize what an engineer is, these facts must be brought before the public. It is with this purpose in mind that the Engineering Open House is presented and this issue of the Technograph is printed.

Do you own everything you would like?

If not, perhaps the problem of worker lay-offs could be solved

EVERY MAN, woman and child in America knows of many things he would buy if he could afford them—that is, if the price were low enough. Cutting prices to the point retailers and manufacturers lose money and go bankrupt is no answer. Cutting *costs* is.

Suppose every producer (mine, farm, factory) equipped itself with the most modern productive equipment—and fair tax laws let them save enough to pay for that equipment. Then let every worker use that equipment at maximum efficiency.

Costs would tumble.

Then let business pass those savings on to the public.

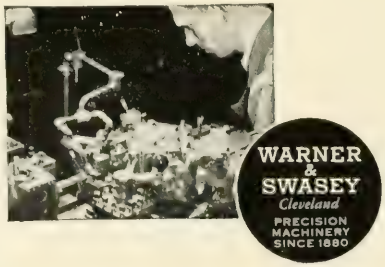
Prices would tumble.

Finally, suppose the consumer did his part, and bought. There would be such business as the world never dreamed of. More store clerks would be needed to handle the demand, more transportation workers to haul the goods, more workers to produce them. The more demand and production, the lower the costs and prices; the lower the costs and prices, the more the demand and production. And everyone would have more and more of the things he wants.

Why isn't it done? Greed, fear, misunderstanding.

Honesty, hard work, unselfishness would do it, for the principle has been proven a thousand times. We've tried laws, contracts, strikes, slowdowns—and all we've got is hatreds, shortages, and periodic lay-offs. Is there a leader great enough to rally all America to put this *positive* approach to work? The approach that every honest man knows in his heart is *right.*

There are employment opportunities at Warner & Swasey for young men of ability and character who believe as firmly in the principles of Americanism as they do in the principles of sound engineering. Write Charles Ufford.



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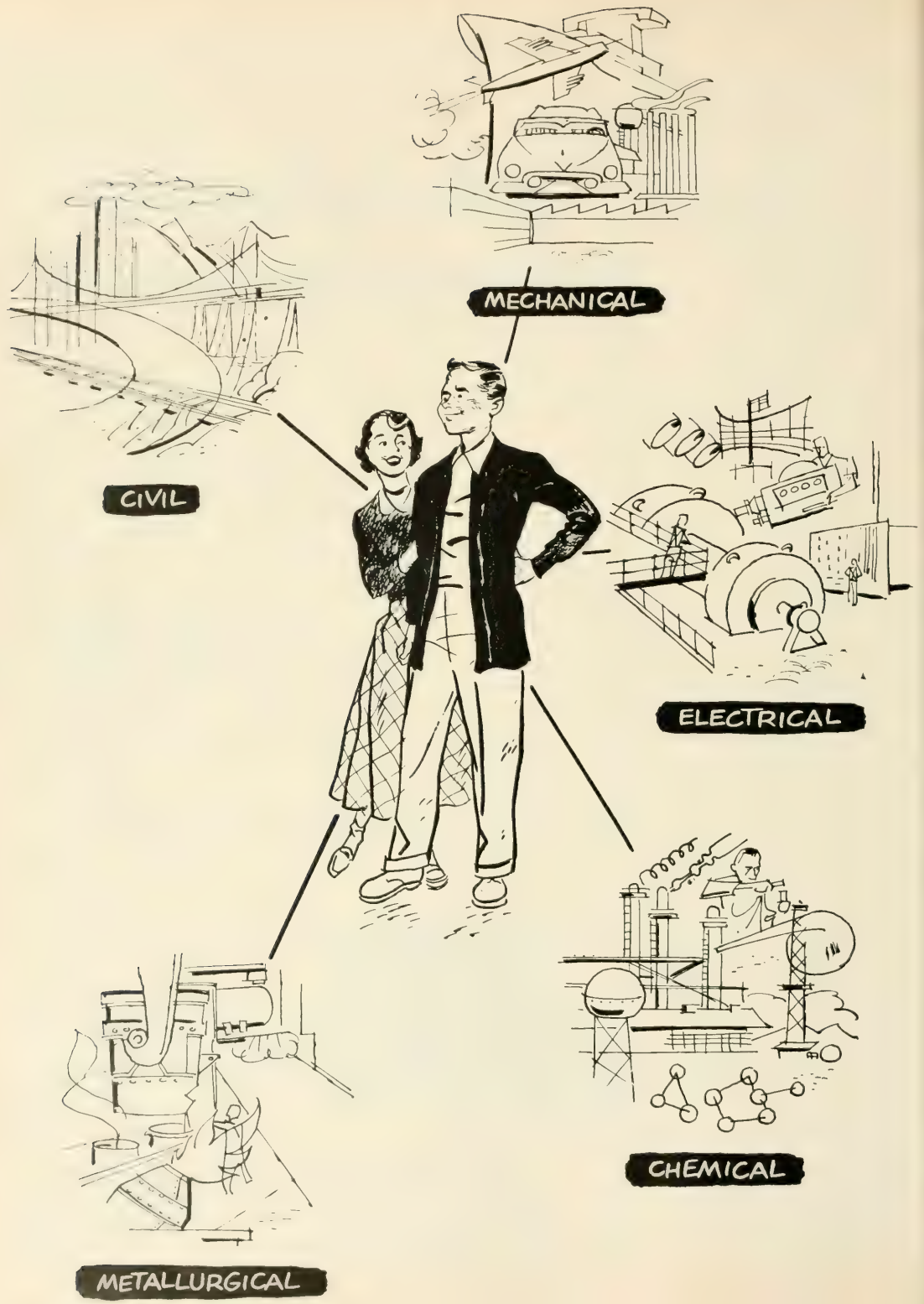
our cover

A preview of your engineering future would envision the design and supervision of construction of numerous structures, machines and devices, some as yet unheard of. Engineering as a science has utilized the forces and materials of nature and has applied them to the needs of man.

Our first four-color cover plates were furnished by Kaiser Aluminum and Chemical Sales, Inc.

our frontispiece

The decision to enter any particular branch of engineering is often a difficult one to make. The advantages of consulting your counsellor and talking over your problems and interests with him cannot be over emphasized. The ultimate choice is with you however, and whichever road you take we wish you success. (Drawing courtesy General Motors Corp.)


MECHANICAL
CIVIL
ELECTRICAL
CHEMICAL
METALLURGICAL

Engineering in Agriculture

by HOWIE HADLER, Ag. E., '55

The United States is a great agricultural nation. Today, a person looking at our nation's farms sees great fields of waving grain, showing proof of our nation's strength in the soil. These fields are the products of years of planning and hard work, however. The methods of making the soil usable and the many machines which are used in farming took long years of hard work and planning to develop. Many of these machines and methods are the products of engineering. The engineer—the man behind the scenes—is a great factor in this nation's agricultural wealth.

At the turn of the century most of the farm work in this country was done by horses. But even before the automobile came into use, the steam engine was put to work on the farm. Steam engines were gradually replaced by the lighter, more compact, internal combustion engines. At first these engines were stationary engines, especially the steam engines, and they were pulled from place to place by horses. Later, they became self-propelled. The early self-propelled engines were not used for tilling the soil, but for pulling and operating heavy harvesting equipment, especially the threshing machine.

Gradually the tractor was made light enough and compact enough for tilling the soil. At first it was used only for the heavier operations, such as plowing, and horses were retained for the lighter and more exact work, such as cultivation. The tractor design was later changed by putting narrow wheels or a single wheel on the front of the tractor. This was to facilitate operation in row crops, such as corn.

Today tractors range in size from very small tractors for truck farmers to giant track-type tractors for heavy work and large acreage farming. Each of these tractors has been designed with a specific purpose in mind—to get the work done better, faster, and more economically. Different tractors are designed differently in order to handle the specific job the designer had in mind. There are row-crop tractors for cultivation and harvesting the crops planted in rows, and there are wide front wheel and track-type tractors for heavy work demanding a great deal of traction.

The tractor is the brain-child of an engineer. The engineer must design the tractor for the job it is to do; he must be sure that all points of stress are strong enough to handle the load the tractor will be subjected to; he must

(Continued on page 30)

A Caterpillar tractor equipped with a beet loader harvesting 115 acres of beets on a farm near Hardin, Montana.

Experimental four row corn pickers being pushed by diesel tractors on a farm at El Paso, Illinois. (All cuts courtesy Caterpillar Tractor Company)

the Technograph features the . . .

1953 Engineering Open House

by DICK CHESTER, Met. E., '54

For 363 days out of the year the campus north of Green Street is quiet and inhabited only by the engineering students. During the other two days of the year the engineering campus is filled with milling crowds of people, the purr of machinery, and the flickering of electrical apparatus. These two days represent the annual Engineering Open House.

It is during these two days that each engineering school and society opens its doors to the public. Each school tries to out do the others with displays of complicated apparatus that awe the crowds of spectators. The Open House offers displays in every type of engineering taught at Illinois. At this time the public may spend an educational day or two, wandering from one building to the other seeing hundreds of displays, which include everything from the making of delicate pottery in the Ceramic Building to the breaking of concrete cylinders in the Talbot Laboratory.

The Open House of 1953 will be held on Friday and Saturday, March 27 and 28. To the outsider only the surface of the Open House is visible. They do not see the hours of work which went into the planning and running of the Open House. Work on the Open House was started during the first semester by a small group of students and faculty. This working force has been growing in number constantly. By the time the Open House is in progress, this force will include almost every student and faculty member in the Engineering College.

Work on the Open House was started by the general chairman, Bob Schrader, in September of 1952. Bob appointed a group of students, each a chairman in a certain phase of the arrangements. Those appointed: Harold Harper, secretary-treasurer; Gordon Booz, program committee; Melvin Rudich, publicity committee; Martin Goldstein and Bob Hardin, physical arrangements; Dick Chester, special assistant.

These men worked together making the primary arrangements and laying the foundation for the vast amount of planning and co-ordination which went into the Open House. A number of students were appointed to each committee to assist the chairman in his numerous tasks. Right before Christmas a representative from each department joined the above mentioned group. These representatives worked together to co-ordinate the actual displays of each department into what the spectators will see as a well knit Open House.

The history of the Engineering Open House is a long and colorful one. The idea was first conceived by the Physics Department in 1906 when they held an exhibit. In 1907 the E.E. department picked up the idea, and in order to make money for a memorial to Robert Fulton, they staged a production. These productions were quite successful, and they were staged every year up into the thirties.

The first all-Engineering Open House was held in the spring of 1920. Another was held the following year, and they became a standard on the campus. They were held every two or four years until they were interrupted by World War II. The first Open House after the war was held on March 31-April 1 of 1950. The second one after the war was held on the weekend of March 14, 1952. It was such a large success that it was decided to hold one every year. So now the Open House has become an annual affair on the campus.

The route for the Open House has been set up in the form of a circle. The spectators may start in any building, and by following the route will be able to see all the exhibits without any repitition. The route and a list of the displays to be found in each building will be found in the Open House program

For the benefit of the spectators information desks will be set up at the entrance of every building. Lunch stands will also be operated for those attending the Open House who are not on diets. They may be found in the East Chemistry Building, Unit Operations Laboratory, Aeronautical Labora-

tory, and the Mechanical Engineering Building. Many other services have been arranged for the benefit of the public. A free bus service will take the spectators to the exhibits which are located outside of the Engineering Campus. Special parking permits will also be issued to those attending who have cars.

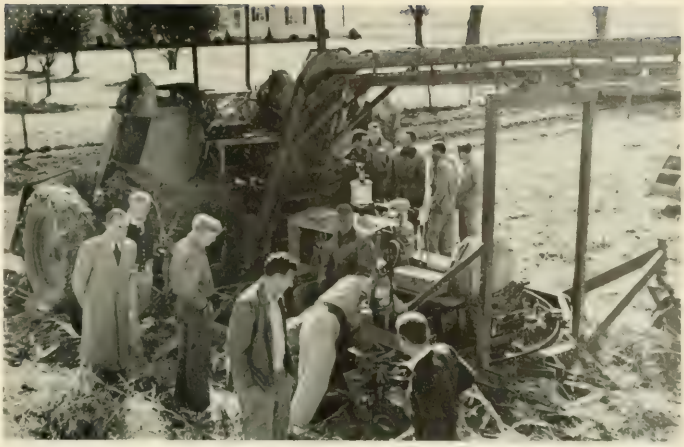
Some of the outstanding exhibits to be found in each of the buildings are as follows:

Metallurgy Laboratory — Here you will be able to see the fabrication of metals into useful forms. Films will be shown which carry the metal from the ore stage to the forms used by everyone. They will show the many processes used in the extraction of the metal from the ore, and the fabrication of these metals into useful forms.

In the furnace room, metals will be melted and cast into ingots. Also the effects of heat treating these metals will be demonstrated. Many devices used in the inspection of metals for impurities, flaws, and their constituents will be demonstrated.

Mining Laboratory — Scale models of various mining methods will be exhibited. Demonstrations will illustrate various ways in which ores are concentrated and separated from gangue material. There will also be a display of the important minerals found in this country. A tour will take you through some of the most modern mine ventilation equipment used in this country. This department has one of the noisiest exhibits found in the Open House. It is the test for the explosibility of coal dust, flour, and sulfur.

Ceramic Engineering — A demonstration will show the steps used in the making of bricks. There will also be an exhibit depicting the values of porcelain enamels and demonstrations of enamel applicability. Steps in the making of dinnerware and some of the properties of ceramic whiteware will be shown. One exhibit will show the development of glass through research and engineering into versatile material.



Part of the agricultural engineering exhibit being viewed by spectators.

Railway Wheel Laboratory — Here you will see some of the tests made on railroad wheels in order to provide better service in the future.

Foundry—There will be demonstrations showing the making of sand molds, and the methods used in casting various metals. Cast iron will be poured many times throughout the day. There will also be samples of the castings distributed.

Talbot Laboratory—This is one of the most fascinating exhibits in the Open House. Many different types of materials will be tested as to their stresses and strains. The testing machine used is one of a capacity of 3,000,000 lbs. You will be able to see many different types of interesting demonstrations and experiments pertaining to the flow of liquids.

Transportation Building — This building will contain exhibits showing the methods used in making engineering drawing. One exhibit will contain over fifty different types of slide rules, and another display the nineteen patent drawings which "have changed civilization."

Physics Laboratory— This exhibit will be highlighted by a half-hour lecture and demonstration of some of the primary principles of physics. Two extensive displays will deal with polarized light and the modern physics of atomic and nuclear energies.

Chemical Engineering Building — There will be exhibits which deal with almost every branch of modern chemistry. One will show the diffusional properties of various elements by the use of radioactive tracers. An absorption tower will be operated to illustrate the principle of separation of two gases. Movies will be shown throughout the day.

Mechanical Engineering Laboratory —The mechanical laboratory will feature a cutaway model of a jet aircraft engine, apparatus for testing air conditioning systems, and a high altitude chamber. The Agricultural Engineering display will be held in this building. The exhibit will include displays of farm mechanization, rural electrification, and soil conservation. The tool design laboratory will have a display of tools and production plant layouts.

Aeronautical Engineering Laboratories—The wind tunnel will be in operation during the Open House to demonstrate lift, drag, and air flow. There will be cutaway models of various types of airplane engines.

Electrical Engineering—This building will be filled with many interesting

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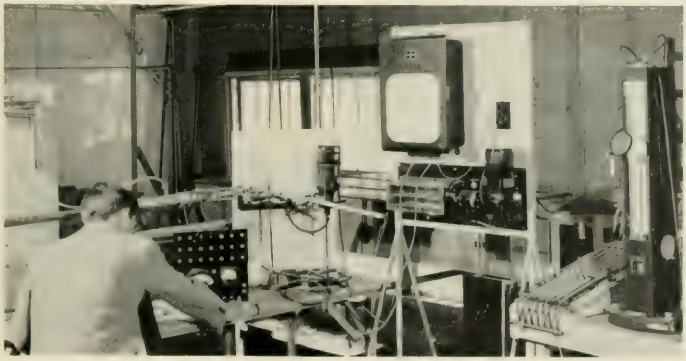


Mining engineering opened some of its research facilities to the public at the last Open House.

best ECMA feature article . . .

America's Superhighways

by LORELLE SWOPE

Wouldn't it be a pleasure to be able to climb into your car in Ames and drive to Chicago, Denver, Des Moines or any other large city in the United States on a superhighway? Think of cruising over a four-lane highway which is unobstructed by traffic signals, congested city traffic, or dangerous intersections. At the present, such a dream is having its birth in the recent rapid trend toward the building of superhighways called turnpikes.

A superhighway has the essential feature of being a very broad concrete road with a minimum of curves and hills. Such a road is designed to facilitate a large volume of cars traveling at high but safe speeds, thus lessening the danger of accidents. Unfortunately, due to the terrific cost of modern highways, available state and federal funds have been limited and, as a result, not many of these huge expressways have been built. The recently constructed superhighways have been financed solely through the floatation of bond issues, which are being repaid through the collection of fees from the users of the highways. Hence, the common terms, toll road or turnpike, have been applied to these roads.

The growth of modern toll roads or turnpikes has been very recent, covering a span of but 15 years. Actually toll roads have a long history reaching back to the days of the American Revolution. Our government at that time had financial troubles, but something had to be done to foster the westward movement. The absence of roads hampered travel, so the government encouraged the building of private roads not only for transportation, but also to stimulate business. These private roads became the first toll roads—a fee being charged for their use by the owners.

Private roads began to die out about 1840 when the railroads and the building of public roads commenced to offer serious and overwhelming competition. It was not until almost a century later before toll roads made their reappearance. This major reappearance was heralded by the building of the Pennsylvania Turnpike.

The world-famous Pennsylvania Turnpike wending its way through the majestic Allegheny Mountains in Western Pennsylvania.

This seemed to be an anomalous situation. Why should a method of transportation come back so strong after a lapse of 100 years? The answer lies in the reasons behind the creation of the Pennsylvania Turnpike Authority.

In 1937, a committee favorably reported to the Pennsylvania Legislature on the feasibility of building a toll road. Reasons given were that Pennsylvania needed a highway which would skirt heavy industrial areas, carry heavy traffic and aid travel in the Allegheny Mountains—but the financing of such a road created special problems. The depression was then still in effect and, consequently, money was scarce. The money needed to finance a road of the caliber desired would not be available if the road was to be a free highway. Making the road a toll road seemed to offer the best possible solution. This proposal was finally accepted despite severe opposition.

The construction of the highway over an old right-of-way formerly owned by the Vanderbuilt Railroad began in 1938, and in October of 1940 the first 160 miles were opened to traffic. World War II intervened before anymore of the Turnpike was completed. Then in 1948, construction commenced again until the system was completed last year. This superhighway extends from Philadelphia to the eastern Ohio border, a distance of 327 miles through the southern Pennsylvania countryside.

The Turnpike System has been a success from the start. Trucking companies at first were rather reluctant in using the Turnpike. They soon found that the toll price was more than compensated for by the savings in time and money spent for gasoline, tires and depreciation on the trucks. Drivers appreciated not only the time saving angle, but also favored the perfect driving conditions over the route.

When the Turnpike was first instituted, towns along the route feared they would become isolated from commercial traffic. Actually these cities have grown more prosperous in the last

few years from the tourist and resort trade traveling over the highway.

The Turnpike is four lanes over its entire length, composed of two traffic lanes in each direction which are divided by a 10 foot middle strip. The width of each two lane section is 24 feet bordered by 10 foot shoulders.

The highway has no railroad or highway intersections, the crossings being made by over and under bridging. At only important points of connection to other roads and special industrial areas is one able to exit from the road. Leaving the road is done by a special interchange having a cloverleaf type of design. This design permits a continuous flow of traffic and eliminates dangerous intersections. There are no traffic lights on the entire system. The curves are long and sweeping with a minimum radius of 1000 feet. The grades are very gradual with the maximum grade being only 3 per cent. Although varying speed limits are maintained along the highway, it is still designed for a high speed of 70 miles per hour. Gasoline stations and restaurant facilities are strategically located along the entire highway. The design of the highway has been such that 90 per cent of all causes of accidents such as side swiping and head-on collisions have been eliminated.

The Pennsylvania Turnpike is well equipped with modern radio communication to facilitate traffic, aid highway patrolmen and to keep authorities posted on highway difficulties.

One feature of the Turnpike is that it goes through the Appalachian Mountains in many places by means of tunnels instead of going around or over them as in other highways. On the old Vanderbuilt Railroad right-of-way, there were several tunnels which had been partially built and offered an excellent means to by-pass the mountains if they were completed. The Turnpike Commission found that it would be advantageous to finish these tunnels.

In these large tunnels, air must be propelled through the tunnel at 1,200,000 cfm. in order to keep the carbon monoxide concentration down to the allowable 4 parts per 10,000 parts of air.

An aerial view of the New Jersey Turnpike in the northern section of the state showing one of the large interchanges in Newark.

The carbon monoxide content in all the tunnels is continuously being checked by analyzers. When the allowable carbon monoxide content is exceeded, a red light flashes on and alarm bells ring to warn the operator to increase the ventilating flow.

The success of the Pennsylvania Turnpike stimulated other states in considering the construction of turnpikes. New Jersey was one of the first to really begin construction of a super highway. Its highway, the New Jersey Turnpike, represents an outlay of $250,000,000 for the construction of its 118 miles of road extending between the George Washington Bridge in New York to Wilmington, Delaware. Several factors were responsible for this extreme construction cost. The route passes through one of the most densely populated and heavily industrialized areas in the nation; hence, the right of way and engineering costs were very high. Costs were further increased by the problems faced in constructing the road over large swampy areas.

The New Jersey Turnpike lays claim to being the world's heaviest road bed for its flexible type pavement construction. It is composed of a four and one half inch thick asphaltic concrete top layer. This top layer is supported by six and one half inches and seven and one half inch thick layers of crushed rock plus a foundation of from 18 to 24 inches of frost free material overlying the normal earthen base.

One feature of the Turnpike is that it has two special bridges, one spanning the Passaic River and the other the Hackensack River. Each has a main span of 375 feet. This span sets the record for the largest plate girder span of its type.

One serious problem encountered was in building the road over a marsh called the New Jersey Meadows. To avoid the heavily industrialized areas around

(Continued on page 26)

Toll Plaza at Interchange No. 1 called the Delaware Memorial Bridge Interchange and located at Deepwater, New Jersey—this is the southern terminus of the New Jersey Turnpike.

Introducing . . .

by F. A. Kuhlmeier, E.E., '56, R. H. Hardin, E.E., '54, Roger Funk, E.E., '56, and David M. Cohn, E.E., '55

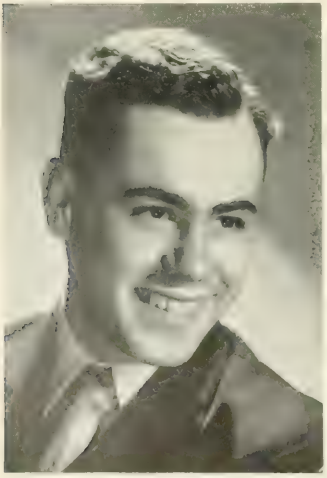
GORDON BOOZ

Gordon Booz, senior in Aeronautical Engineering here at Illinois, not only has a high scholastic average but is very active in student affairs.

Gordon graduated from Colchester High School (Colchester, Illinois) in 1949 as salutatorian of his class; whereupon, he received a county scholarship here at the University of Illinois. Since then Gordon has been active in many student activities. He is a member of the Institute of the Aeronautical Science (IAS) where he has served as both secretary-treasurer and president. He is a member of the Arnold Air Society. Last semester Gordon was elected the chairman of Gamma Alpha Rho which is an honorary fraternity for juniors and seniors in Aeronautical Engineering.

Flying, one of Gordon's prime interests, was furthered when received a scholarship from the Cleveland Air Foundation. Upon completion of this flight course he received his private license.

Gordon's hobby, model airplane building, has been shelved since his marriage



GORDON BOOZ

in 1950 as he and his young son, Ronn, do not, as yet, see eye to eye in the construction of aircraft.

This is the third time that Gordon has worked on the Engineering Open House and this year he is chairman of the program committee. The first job of the program committee, each year, is to make up the programs. So he, his wife, and even some of the neighbors worked long and hard during Christmas vacation getting the exhibits edited and listed in the program. Another function of the program committee is selecting judges and giving out the awards for the best exhibits. During the time the open house is in progress this committee is in charge of the central headquarters which is the brain or coordinating group of the whole operation.

Gordon is presently employed by the U. S. Geological Survey(Water Resources Division) which is in charge of the surface water records for the state of Illinois. It is his job to read the water gages at check points located along various rivers and streams in this area and then combine and correlate this data into a report. The report is then sent to the Army Engineers at Washington where it is used for studying flood control.

Gordon's plans are fairly well decided for the next few years, for after his graduation in February of 1954 he will enter the Air Force as a second lieutenant. While in the service he plans to study meterology. After Gordon receives his discharge from the Air Force he plans to enter industry and specialize in the design of air craft powerplants.

PROFESSOR J. E. WILLIAMS

Professor J. E. Williams of the electrical engineering department heads up the faculty participation in the 1953 Engineering Open House as Chairman of the faculty advisory committee. He has offered many new suggestions and ideas to make the show bigger and better this year, drawing from his experience as chairman of the Engineering Show at Michigan College of Mining and Technology in 1933.

Professor Williams came to Illinois in 1946 from the General Electric Company, where he had worked since 1941 in the induction motor design department. Prior to this, he had been an instructor at Ohio State University.

He received his B.S. in E.E. from Michigan College of Mining and Technology in 1933, and his M.S. from Ohio State in 1941. His home town is Iron Mountain, Michigan, in Michigan's upper peninsula, and of course, he likes to return to this area on vacations.

Professor Williams is a member of AIEE, Tau Beta Pi, and Eta Kappa Nu.

As chairman of the faculty advisory committee for the 1953 Engineering Open House, Professor Williams states that faculty assistance and cooperation

PROFESSOR J. E. WILLIAMS

with students has reached a new high this year, and that the Open House will be informative and entertaining and will leave a lasting impression on all those who see it.

BOB SCHRADER

Bob Schrader is one of the finest fellows anyone would want to meet. He has the spirit of cooperation needed by anyone who works with a group of people. This year he is the able-bodied Assistant Editor of the Technograph. Last year he wrote the Boneyard Bilge which is no little accomplishment in itself.

Bob says sacking out is probably one of his favorite pastimes, and he is known as the sack out artist of Triangle Fraternity. This seems rather hard to believe after looking over the list of activities in which he is participating.

Besides all his Technograph work, he found time last year to be in charge of programs for the Engineering Open House, as well as being a sophomore manager for the Star Course. This year as a junior in Chemical Engineering he is the General Chairman of the Engi-

(Continued on page 64)

Can I be an Engineer?

(courtesy of the Department of Public Relations, General Motors Corporation)

edited by MAURICE GARNHOLZ, Aero. E., '56

Wherever you look you will see the work of engineers. Buildings, streets, machines, automobiles, furniture are all the result of engineering. They have come out of the little bits of scientific knowledge discovered over the past hundreds and thousands of years, building up piece by piece from simple beginnings.

Almost any common ordinary thing —a door knob or window shade—was at one time an intricate mechanical problem, and some engineer—whether called that or not—had to work out a way to build it.

Some of our newer marvels—like television—are more complex. No one man suddenly invented it out of his own head. It came out of the storehouse of knowledge which has been built up over the years in various fields of electricity and other sciences. But it required somebody who was familiar with that accumulated knowledge, could make use of the right parts of it and put them together in a workable system of television. In other words, it took an engineer to do the job.

This is an Age of Science, and more and more technical men are needed—technicians, scientists, engineers — men to develop new products and others to design them, test them, produce them and sell them. More women, too, are getting into technical work, particularly in the fields of science and research and to some extent in engineering.

It is hoped that this article will be of some help to you in deciding on your future plans, but be sure to talk to your parents, teacher or guidance counsellor about your personal situation, they know you and your record and aptitudes, and can give you valuable assistance in making your choice.

What is an Engineer?

No simple definition exists. The dictionary says that originally an engineer was a "designer and constructor of engines," but it then goes on with a long and complicated paragraph to try to explain what the word means now.

There are many different kinds of engineers and various overlapping groups such as scientists and research workers. There are also such jobs as technician and draftsman, which may not require a college engineering degree but do involve some of the same types of problems. The word "engineer" is used in a broad sense in this article, since what we have to say applies pretty much to all these classifications.

Probably the best way to define engineering is to break it down and explain a little bit about its various branches. In the following paragraphs five main groups are described with their corresponding jobs.

Of course each group can be broken down further, and each offers a great variety of kinds of work. Some engineers go into research work, specializing in some of the fundamentals of science. At what might be considered the other extreme is the production engineer, who is responsible for the actual building of the product in the best and most economical way. In between are many other varieties, so there are actually hundreds or thousands of different types of jobs all labeled "engineering."

The *civil engineer* is responsible for the design, construction and maintenance of buildings, highways, railroads, bridges, dams, airfields, canals, water and sewage systems, harbors, tunnels and surveying. Typical jobs are those carried out by the airport engineer, bridge engineer, municipal engineer, and sanitation engineer.

Mining and metallurgical engineering deals with the locating and extraction of mineral deposits, reduction and refining of ores, manufacture of alloys, and processing of metallic and nonmetallic substances into useful structures and shapes. The metallurgical engineer deals with materials rather than machines. Employment as a materials engineer, rolling mill superintendent, welding engineer, manager of smelter, or foundry engineer are representative of this branch.

Mechanical engineering is one of the largest fields of engineering, broadly covering power development and manufacturing. It involves the design and production of machinery, machine tools, engines, turbines, boilers, automobiles, trains, airplanes, ships, etc. It includes the design and operation of plants to manufacture other products. Positions as an automotive engineer, jet propulsion engineer, production engineer, tool engineer, plant supervisor, industrial engineer represent the opportunities to be found in this field.

The *chemical engineer* is interested in the industrial application of chemistry and chemical products, a field which is growing by leaps and bounds. He is responsible for the production and processing of foodstuffs, rubber, petroleum, coal, leather, plastics and other synthetic materials and thousands of other products. He may become an atomic energy scientist, petroleum engineer, sales and service engineer, plastics plant manager, or an industrial chemist.

Electrical engineering is a rapidly expanding branch of engineering because of the new industrial applications of electronics and atomic power. The electrical engineer is concerned with the generation and transmission of electrical power, the design and manufacture of motors, generators, electrical instruments, controls and appliances, as well as many activities in such fields as lighting, communications, television and radar. Jobs as television engineer, power plant superintendent, electronics engineer, lighting engineer, telephone superintendent typify the ones to be found in this field.

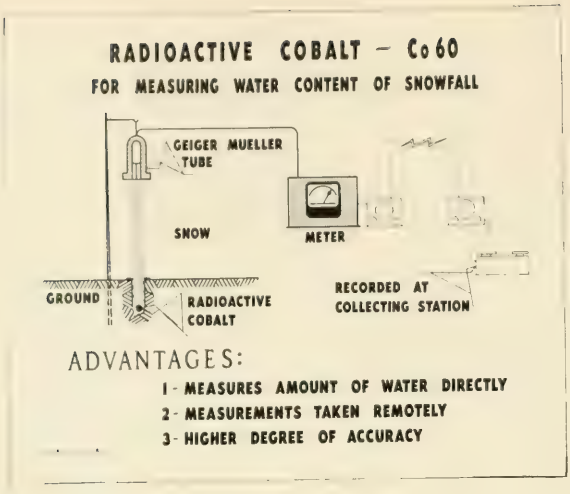
Why should I take engineering?

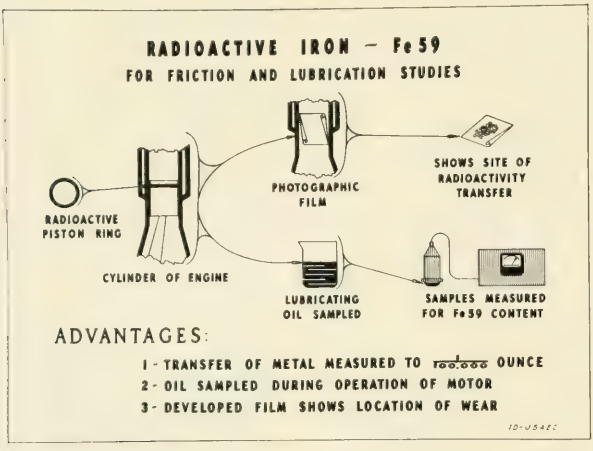
There are many good reasons. Not *everybody* would make a *good engineer* —or a good doctor or a good salesman. But assuming there's no good reason you shouldn't be an engineer or scientist, here are a few facts which might influence your decision.

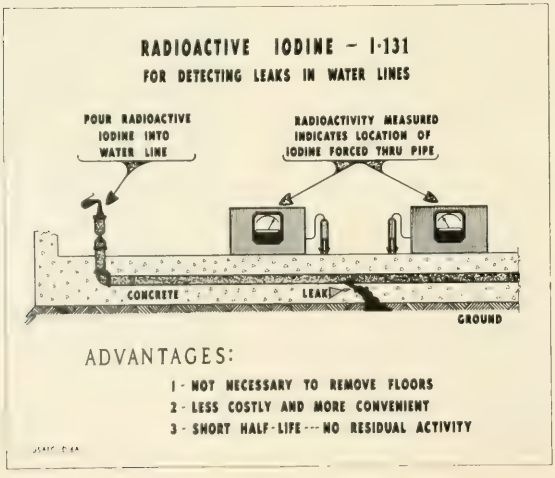
Job hunting will probably be the first thing you will do when you finish college. Experts state that this country will need about 30,000 new engineers each year for some time to come. The engineering schools will graduate just about half that number.

This situation probably won't go on forever. Supply and demand in the engineering field will vary over the years just as they do in every business. But this country is growing faster and faster, and it must have engineers to design and build the things we'll need.

(Continued on page 30)




RADIOACTIVE IRON – Fe 59
FOR FRICTION AND LUBRICATION STUDIES
RADIOACTIVE PISTON RING
CYLINDER OF ENGINE
PHOTOGRAPHIC FILM
SHOWS SITE OF RADIOACTIVITY TRANSFER
LUBRICATING OIL SAMPLED
SAMPLES MEASURED FOR Fe 59 CONTENT
ADVANTAGES:
1 - TRANSFER OF METAL MEASURED TO 1/100,000 OUNCE
2 - OIL SAMPLED DURING OPERATION OF MOTOR
3 - DEVELOPED FILM SHOWS LOCATION OF WEAR
ID-USAEC


RADIOACTIVE IODINE – I-131
FOR DETECTING LEAKS IN WATER LINES
POUR RADIOACTIVE IODINE INTO WATER LINE
RADIOACTIVITY MEASURED INDICATES LOCATION OF IODINE FORCED THRU PIPE
CONCRETE
LEAK
GROUND
ADVANTAGES:
1 - NOT NECESSARY TO REMOVE FLOORS
2 - LESS COSTLY AND MORE CONVENIENT
3 - SHORT HALF-LIFE --- NO RESIDUAL ACTIVITY

Peacetime Uses of...

When we hear that term, most of us immediately think of bombs, war, and destruction. However, we have that impression because we are not aware of the true facts about the production and utilization of atomic energy.

The problem of atomic energy is not going to be solved overnight, but rather the problems facing the engineers will be unsolved for a while to come. There are opportunities available for most any type of engineering in the field of atomic energy. For the mechanical engineer there is the problem of heat exchangers for the atomic power plants; to the metallurgist there is the problem of developing a metal that can withstand the high temperatures as well as high nuclear bombardment that takes place in the harnessing of the atom; also, there is an opportunity for the agriculture engineer to utilize the benefits of the tracers, or radioisotopes.

Here, engineers of the future, lies a challenge to modern engineering, with all its various phases, to tame and utilize this modern miracle of today—Atomic Energy.

Sources of Energy

The Atomic Energy Commission manufactures two kinds of atomic fuels — uranium 235 and plutonium 239. The processes are entirely different; in effect, they are the products of two separate industries.

Production of plutonium starts with bars of uranium metal, refined from Congo or Canadian ore. Most of this metal is heavy uranium (U-238), but about one in every one hundred forty atoms is light, fissionable uranium (U-235). The bars are loaded into one of the three atomic piles at the Hanford, Washington, plant, and are left there for several weeks. In the pile, many of the U-235 atoms are split, producing; (1) a couple of lighter (and intensely radioactive) atoms; (2) a lot of energy; and (3) two and a fraction neutrons, on the average. Some of these neutrons are absorbed into atoms of U-238; these atoms then go through a series of transformations and finally become atoms of plutonium 239. Plutonium 239 is an artificial fissionable element which does not occur in nature.

ATOMIC ENERGY

by MEL RUDICH, Gen. E., '53

The uranium rods are then removed from the pile, dissolved in acid, and passed through an elaborate chemical plant, also at Hanford, where the plutonium is extracted. The leftover uranium, working chemicals, and dangerously radioactive fission products are then stored in underground tanks.

There are two methods for the separation of fissionable U-235 from U-238. The first plant to deliver appreciable quantities of U-235 was the electromagnetic plant (known as Y-12) at Oak Ridge, then operated by an Eastman Kodak subsidiary. This plant contains a large number of machines called calutrons, each of which is capable of producing U-235.

The calutron, invented by Dr. Ernest O. Lawrence, designer and builder of the first cyclotron, is a modified and overgrown mass spectrograph. Uranium is ionized—broken down into electrically charged molecules—and the ions are shot at high speed past a tremendous magnet which deflects them to one side. The U-235 ions are deflected more than the slightly heavier nonfissionable U-238. They come out at a different place and therefore can be collected separately.

Unfortunately, no one has yet figured how to ionize uranium in any quantity. Hence each individual machine has a low output, the power consumption is very high, and the manpower required to produce a pound of material is all out of proportion with all alternate methods.

In early 1947, large scale production at Y-12 was halted. While most of the plant is being held in standby, some of the calutrons are still being operated experimentally in an effort to find a way around the low efficiency.

The second and best known of the U-235 plants is the gaseous diffusion (K-25) plant at Oak Ridge. It is believed to be the largest industrial operation ever carried on under one roof. It cost five hundred million dollars to build and is the only one of its type in the world.

In K-25 uranium, combined with fluorine to form a gas, is forced through stage after stage of sieves, barrier membranes. The light isotope, fissionable U-235, goes through the sieves a little more easily than the heavier U-238. After thousands of stages, gaseous U-235 is obtained. This gaseous U-235 is then separated from the fluorine and becomes metallic U-235.

In anticipation of a rapidly growing shortage of uranium, great attention has been given to "breeding," a process in which plutonium is produced by the power reactor at a rate greater than its consumption. It is theoretically possible, but in practice will be very difficult, to build an industrial reactor that will cause excess neutrons to be absorbed in a blanket of U-238, producing plutonium which can serve as new fuel to continue the operation as long as new natural uranium is supplied. This greatly increases the availability of fuel, for the most of the uranium, not just the small U-235 fraction of it, is consumable.

It might even be possible by these means to build up fissionable material faster than it is consumed.

Nevertheless, the engineering difficulties associated with breeding are enormous. Here are a few of them:

For any reasonable thermodynamic efficiency in utilizing the great energies available, it is necessary to operate at temperatures well above the conventional engineering range.

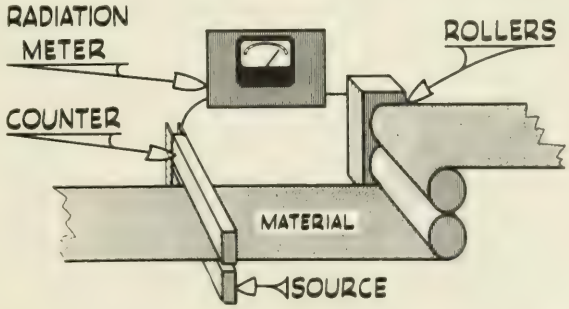
The compactness of reactors which is an important inherent advantage proves troublesome in regard to the heat transfer problems which involve heat transfer rates far transcending previous experience.

The materials chosen for the reactor must withstand not only high temperatures but also high nuclear radiation densities, with unpredictable changes in the physical properties of the materials concerned.

If we finally find a structural

(Continued on page 40)

RADIOACTIVE SOURCE
FOR
GAGING THICKNESS



NO CONTACT - ACCURATE - EASY TO USE

Engineering Hall—home of the civil engineering department and which also houses the offices of the College of Engineering.

a review of the...

Engineering

For a little over a year the Technograph has been featuring articles on the individual departments in the college of engineering. In this article we have tried to give you a picture of engineering at Illinois by tying together excerpts from those articles. Our apologies must go to the TAM, GED, and Ceramic engineering departments, which have not yet been featured in the Technograph.

Civil Engineering

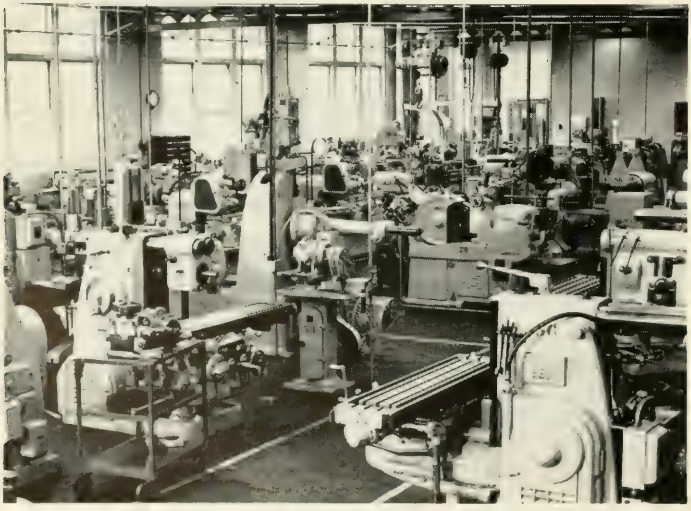
There are probably many questions about the civil engineering curriculum and its purposes. The first question that probably comes in mind is, "What is the curriculum supposed to do for the student?" In a University of Illinois bulletin I found an answer which reads, "While the instruction aims to be practical by giving the student information and practice directly applicable to his future professional work, the object is the development of mental faculties. The power to acquire information and the ability to use it, is held to be of far greater value than any amount of so-called practical acquirements."

In the first year of school all engineering students take the same courses. First semester courses are, chemistry, general engineering drawing, college algebra, trigonometry, rhetoric, engineering lectures, physical education, and military.

Many students will argue that taking certain of these courses is a waste of time. Descriptive geometry, and analytic geometry are particularly condemned. It must be emphasized, however, that these courses are of utmost importance. Descriptive geometry is an engineering drawing course where the student is taught to solve engineering problems graphically. It is designed to make the students think. Analytic geometry is the mathematics of straight lines and curves encountered in plain and solid geometry, and is a stepping stone to the calculus.

Between the first and second years, during the summer session, the student in civil engineering encounters his first C.E. courses. The first course is C.E. 101, surveying theory. In this course taught during the first three weeks of the summer session, the student becomes acquainted with surveying instruments, some of their uses, and computation pertaining to surveying. C.E. 102 (surveying practice) is given in summer camp, which is of five weeks' duration. The summer camp is located in northern Minnesota and actual field conditions prevail.

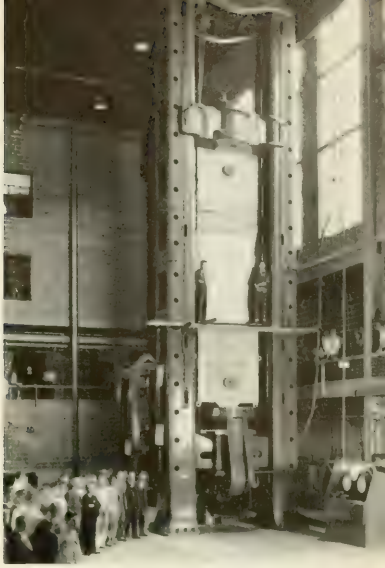
The second year finds the student taking the following courses: *1st semester;* route surveying (C.E. 103), building construction (C.E. 160), calculus, physics, physical education, and military; *2nd semester;* economics or speech, geology, calculus, physics, analytical mechanics (statics), physical education and military. Courses that may need some elaboration are: route surveying, building construction, geology and analytical mechanics. Route surveying concerns the economical planning of transportation routes. This takes in the surveying aspect and the computations encountered in the construction of transportation route. Building construction acquaints the student with the different types of building materials, and their proper uses. Geology gives the student his first contact with soil and rock problems. This course lays the ground work for the soil courses that are to follow. Analytical mechanics is the mathematical analysis of force systems and simple trusses, when no motion takes place in the systems under consideration.



Room 217 of the new M. E. building contains more than one hundred machine tools and is designated the Machine Tool Laboratory.

Departments

edited by BOB SCHRADER, Chem. E., '54



Full scale view of testing machine in Talbot Laboratory.

The civil engineering student in the third year takes the following courses: 1*st semester*, soil and bituminous materials (C.E. 230), plain concrete (C.E. 235), structural analysis (C.E. 261), mechanical power equipment (M.E. 201), analytical mechanics (Dynamics), and resistance of materials; 2*nd semester*, highways (C.E. 220), structural analysis (C.E. 262), elementary structural design (C.E. 263), fluid mechanics and electives. Soils and bituminous materials deals with these materials as encountered in engineering work and emphasizes their uses and limitations. Plain concrete gives the student a knowledge of how concrete is made, the factors upon which the concrete's strength depends and the design of a concrete mix of desired strength. Structural analysis deals with the analyzation of simple structures to determine stresses in members and maximum safe loads applicable. Mechanical power equipment provides the student with the knowledge of different types of engines and their uses. Analytical mechanics (Dynamics) teaches students to analyze machines in motion. Resistance of materials is a study of the interior stress of a material which is evidenced when the material is loaded. Highways deals with the material used in highway construction (surface and sub-surface). Structural analysis is a continuation of the first course in structure. Elementary structural design deals with the fundamentals of design work in the medias of steel and reinforced concrete. Fluid mechanics is concerned with the problems encountered in the flow of fluids in pipes, channels, nozzles.

In the fourth year the student chooses his option in civil engineering. By choosing an option he chooses a phase of civil engineering in which he wishes to specialize. The options open to students include: general construction, highway, hydraulics, railway, and structural. After the option is chosen the student concentrates on courses pertaining to his chosen option.

Mechanical Engineering

Today the M. E. department is the largest in the engineering college with an undergraduate enrollment of about 550 students and a faculty staff of nearly 100. In addition 26 men are currently working on their doctorates and 24 on their masters degrees. The department has indeed advanced a long way since the first classes were conducted in a converted mule stable.

Aside from physical expansion, the M. E. department has greatly enlarged and improved its curriculum. The option system has been inaugurated so as to provide the student with a convenient means of placing emphasis on any one of the following phases: aeronautical, air conditioning and refrigeration, machine design, petroleum production, power, research, production, railway motive power, and general (which permits the student to select about 24 hours of either technical work cutting across the special options, or of non-technical electives in other colleges). Plans are now nearly completed for an additional option, which is, in effect, a new curriculum within the M. E. department. This

This view of the modern Electrical Engineering Building shows how engineers have kept up with the trend of the times.

new course of study leads to a degree in industrial engineering, a phase of engineering which is becoming more and more important every day.

A primary objective of the M. E. department is to provide the student with the best general education possible and at the same time not sacrifice any courses needed for graduation. This policy is in line with the views of men who are today far advanced in the engineering profession, and who have learned by experience that this type of education and character development plays a very important part in their lives.

Electrical Engineering

The E.E. department continued to expand until it was decided that there just was not enough space to accommodate the large number of men desirous of entering this rapidly growing field. In February of 1947, construction began on the present E.E. building. The structure was built at a cost of $1,300,000 and an additional $300,000 was spent for equipment at that time. The building was dedicated in 1949. Since that time, many additional appropriations have been granted for equipment, until today, the electrical engineering school at the University of Illinois is one of the finest and best equipped in the country.

The new building's 80,000 square feet of floor area is divided into three floors and a penthouse. Most of the space is taken up by laboratories and offices. There are just 13 classrooms in the E.E. building. Most of these are located on the third floor along with the electronics, communications, radio, and ultra high frequency laboratories. The new network analyzer is also located on the second floor along with the network analyzer conference room. Laboratories and shops for the servicing of equipment, and instrument rooms are found on the second floor.

The first floor houses about half of the office space along with circuits and measurements laboratory. The E.E. lounge is in the northeast corner of this floor. Two lecture rooms with upholstered theatre type seats are located on this floor and are used for hour exams, club meetings, and seminars.

Downstairs, the largest area is used for the power lab. The power lab has a large plate glass window which allows visitors to see the entire lab. The lab has its own instrument room. Immediately in back of the power lab, the E.E. building shop is located. This is a complete machine shop used by building and machinery maintenance men.

The building has its own power substation, and a system of panel boards which permits the delivery of various AC and DC voltages to any lab in the building. For safety, the power lab has emergency push buttons located on every column. These buttons kill all the power in the lab with the exception of the lighting circuit.

The power lab here at the University is one of the largest labs of its kind in any educational institution. It has been the policy of the department to furnish enough equipment in all of its labs so that an entire lab section may work on the same experiment at the same time. This means several sets of each kind of equipment. The department feels, however, that the expense of this duplication of equipment is warranted by the savings in instruction time. The lab instructors spend less time in explaining the experiments and have more time for giving individual help.

While less impressive perhaps, the electronics and communications labs are no less completely equipped. In the communications lab, transmission of intelligence along wires is studied. The lab contains several artificial lines simulating several miles of open-wire and twisted pair lines.

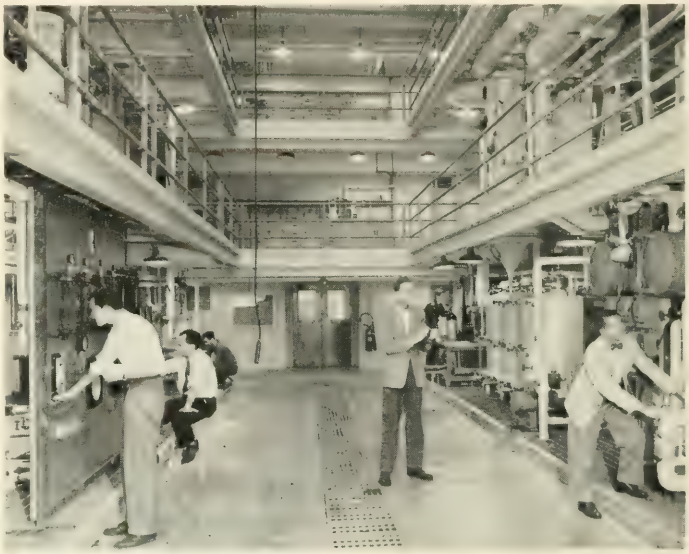
The radio lab contains all the necessary equipment for a comprehensive study of present-day radio circuits. Modern AM and FM receivers are laid out on large "breadboard" type layouts, permitting graphic demonstration of the functions of the various elements making up a modern radio receiver.

The penthouse of the E.E. building, added to the building after its completion, houses the antenna laboratory. Here measurements of radio wave field strength are made, and various antenna designs are studied.

Chemical Engineering

There are two optional curricula in chemical engineering, one requiring four years of study and the other five years. The four-year curriculum is for the high school graduates who have had good training in high school chemistry, physics, mathematics, and German or French. In this curriculum, there are a number of special courses which are offered only to chemists and chemical engineers. These courses have accelerated schedules which are made possible by the excellence of the high school training. For students who can not get the training necessary for the four-year curriculum, the five-year course has been established . This is essentially the same as the shorter course with the difference in the number of hours of elementary chemistry, mathematics, and language. There are also more electives in the five-year curriculum, so that more liberal arts and economics courses may be taken. Students who are particularly interested in sales and administration in the chemical and oil industries often take the longer curriculum.

(Continued on page 22)



The Unit Operations Laboratory, largest laboratory in the chemical engineering building extends through three stories.

earthquake!

Precisely at 4:50 A. M. in the predawn darkness of last July 21, the most severe California earthquake since 1906 struck the small town of Tehachapi.

Walls were collapsing, buildings were folding. The town's telephone office shook to its foundation and the lights went out. But the night operator remained at her switchboard until it went dead. Main cables to the telephone office were pulled to the ground when a nearby wall caved in.

This was at 4:50 A. M.

At 8:30 A. M., less than 4 hours later, telephone men had reestablished 3 circuits on the edge of town (top picture). Outdoor offices were set up for Red Cross and other emergency workers.

Repairs to the damaged main cable and other equipment were rushed (center picture). By late afternoon the central office switchboard was working. Tehachapi residents were able to make calls to friends and relatives concerned about their safety.

By 9 P. M., two TV stations were sending live telecasts of the damage to Southern California viewers (bottom picture). Telephone men had established a 4-jump radio-relay station in less than 12 hours.

It was a typical disaster—brutal and unannounced. But telephone men were prepared. They quickly restored communication when it was needed most. In so doing, they demonstrated the resourcefulness and technical skill which telephone companies ask of their engineers.

For qualified engineering graduates of this caliber, there are opportunities in the telephone companies. Your college placement officer can give you details. Or write to American Telephone & Telegraph Company, College Relations Section, 195 Broadway, New York 7, N. Y., for the booklet, "Looking Ahead."

BELL TELEPHONE SYSTEM

DEPARTMENTS . . .

(Continued from page 20)

Agricultural Engineering

The department offers a four-year curriculum leading to a degree of Bachelor of Science in agricultural engineering with options permitting the student to choose between a power and machinery, farm structures, or soil and water engineering curriculum.

The power and machinery option includes the designs of machines, the application of machines to farm use, and the development and use of materials for construction of machine components. The farm structures study includes study of design, location, and arrangement of buildings; lighting, heating, ventilation, and functional requirements of farm buildings. Soil and water engineering includes drainage, soil erosion control, irrigation, land clearing, and flood control. The power and machinery option follows the mechanical engineering design course closely, and the farm structures and soil and water engineering option includes civil engineering design. Courses are offered in the fourth major field in agricultural engineering—rural electrification. Included are electric service to rural eras, and the development and use of farm machinery and equipment involving electricity.

The agricultural engineering curriculum follows the common freshman engineering program of study in the first year. In the second year, the study program begins its specialization, and in the third year, the student chooses between one of the two options offered. The program of study is so arranged as to give the student a thorough groundwork of basic engineering courses which are necessary in any engineering field, along with specialized courses necessary to the particular field and agriculture courses needed to give a thorough understanding of problems in agricultural engineering.

Aeronautical Engineering

The curriculum leading to the degree of Bachelor of Science in aeronautical engineering at the University of Illinois is designed in such a manner as to allow the student to concentrate on any one of the three major fields through selection of appropriate technical electives. These three fields are aerodynamics, aircraft propulsion, and aircraft structures. Although each student is re-required to take basic courses in each of the three fields, the curriculum is very flexible for the junior and senior years. In addition to specializing through the selection of electives, the student may register for a special problems course which will allow him to work on problem of particular interest to him with close supervision by a staff member. Probably the brightest star in the picture of the aeronautical engineer educational program at the University of Illinois is the excellent, close student-staff relationship. The pattern here is to mold the curriculum in each individual case so as to produce the best results. A sincere effort is made to allow students to advance as fast as their abilities allow.

Engineering Physics

Engineering physics is more of a pure science type of course than the other engineering curricula. For this reason the requirements to be met, in order that the training received be valuable upon graduation, are quite rigid. It is known as the hardest curriculum in the engineering college, a 3.5 grade average is required, and after graduation, the student should be equipped to handle problems in mechanics dealing with Legrangian equations, problems in electricity and magnetism demanding Maxwell's equations, A. C. circuit analysis and general circuit theory, and also in light, physical and geometric theory of radiation. This curriculum is unlike others in engineering in that no specific option can be selected and followed. However, one of the outstanding features of the course is the large number of elective hours allowed. Up to twenty-nine hours of approved and ten hours of technical electives may be selected. This permits the student to follow some other engineering field if he wishes, or he may choose to receive a broad education by including many non-technical courses. The first two years of engineering physics are very similar to all engineering curricula. In the last two years advanced courses in physics, mathematics, and chemistry are emphasized. As a junior, the student enters the 300 series of physics courses which are quite demanding, and soon "the men are separated from the boys." A look into the records reveals that over the years more than 50% of the students enrolled have attained better than a B average, which leads to stiff competition within the course. The grade and course requirements were not established to discourage the student, but merely to protect him against unemployment upon graduation. Good physicists are very much in demand, but poor ones find it very difficult to obtain employment, especially in normal times. The physicist does not receive specialized training as the normal engineer does, and is consequently required to be thoroughly trained in many fields.

Mining and Metallurgy

Metallurgy is divided into three main divisions: chemical, physical and mechanical metallurgy. Chemical metallurgy is concerned with methods used to produce and refine metals from their ores. The chemical metallurgist attempts to design methods for more efficiently winning metals from their ores, to get rid of impurities in the ore, to develop refining techniques, to study the rate and mechanism of reactions at high temperature, to develop better refactory materials, and to improve general production procedures.

Physical metallurgy deals with the nature, structure, and physical and mechanical properties of metals and alloys. The physical metallurgist studies

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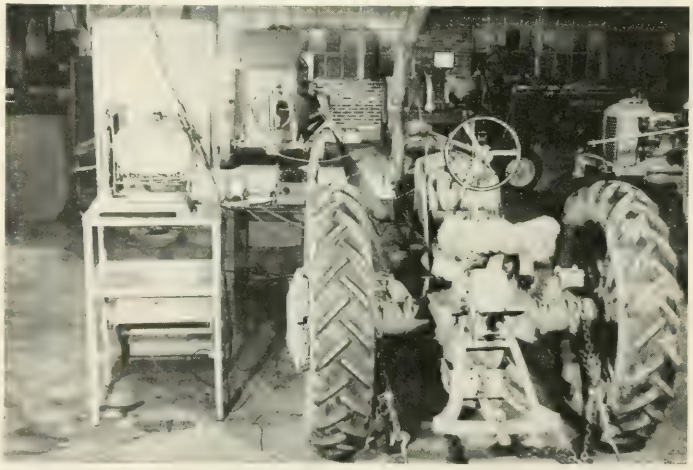
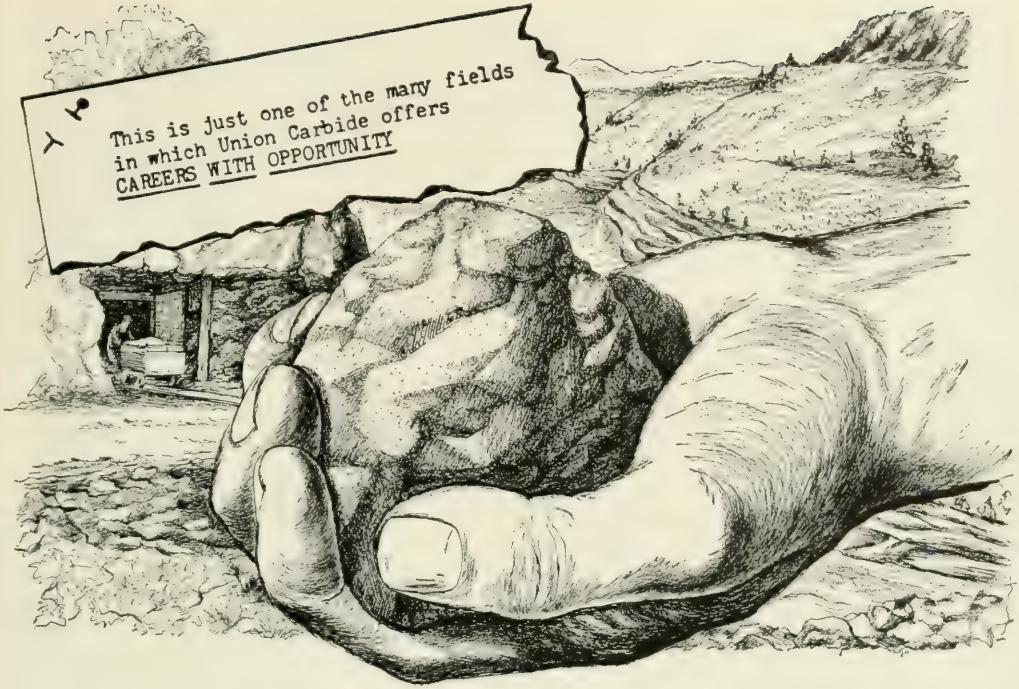


A view of the tractor laboratory showing a tractor ready to be tested on the dynamometer with other tractors and equipment in the background.



Promise of a golden future

Yellow uranium ore from the Colorado Plateau is helping to bring atomic wonders to you

Long ago, Indian braves made their war paint from the colorful sandstones of the Colorado Plateau.

THEY USED URANIUM—Their brilliant yellows came from carnotite, the important uranium-bearing mineral. Early in this century, this ore supplied radium for the famous scientists, Marie and Pierre Curie, and later vanadium for special alloys and steels.

Today, this Plateau—stretching over parts of Colorado, Utah, New Mexico, and Arizona—is our chief domestic source of uranium. Here, new communities thrive; jeeps and airplanes replace the burro; Geiger counters supplant the divining rod and miner's hunch.

From hundreds of mines that are often just small tunnels in the hills, carnotite is hauled to processing mills. After the vanadium is extracted, the uranium, concentrated in the form of "yellow-cake," is shipped to atomic energy plants.

A NEW ERA BECKONS—What does atomic energy promise for you? Already radioactive isotopes are working wonders in medicine, industry, and agriculture. In atomic energy, scientists also see a vision of unknown power—which someday may heat and light your home, and propel submarines, ships, and aircraft. The Indian's war paint is on the march again—toward a golden future.

UCC TAKES AN IMPORTANT PART—The people of Union Carbide locate, mine, and refine uranium ore. They also operate for the Government the huge atomic materials plants at Oak Ridge, Tenn., and Paducah, Ky., and the Oak Ridge National Laboratory, where radioisotopes are made.

STUDENTS and STUDENT ADVISERS: *Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of* ALLOYS, CARBONS, CHEMICALS, GASES, *and Plastics. Ask for booklet B-2.*

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BAKELITE, KRENE, and VINYLITE Plastics · DYNEL Textile Fibers · LINDE Oxygen · SYNTHETIC ORGANIC CHEMICALS

skimming industrial headlines

edited by CHARLES LA ROBADIER, M.E., '55

High School Physics in Big Time

Thumb-worn pages of elementary physics books at G-E laboratory libraries indicate the popularity of simple principles when engineers are stuck for solutions to development problems.

That old principle concerning the boiling point of liquids — which decreases as altitude increases — has been riding high since being lifted from high school physics books to weather balloons for measuring altitudes up to 30 miles.

The principle is wrapped in a tiny and inexpensive G-E instrument called a hypsometer. Liquid is brought to a boil in the device before being sent aloft. As the balloon rises, temperature of the liquid drops, but so does the boiling point. Temperature data from the continuously-boiling liquid are radioed to earthbound observers by the balloon automatic transmitter, and in this way, the balloon's altitude can be calculated.

Dry Shower Testing

How to check a shower without taking one is accomplished by special shower tester used in the General Electric Company's Research Laboratory.

Showers are installed at strategic points in workrooms of the laboratory to douse a scientist in case his clothes catch fire or in the event of acid burn.

Although they rarely are used, showers have to be in working order and are checked periodically. A special tester permits water from the shower to be squirted into a large funnel, from which it is carried into a can. A hose conducts the water to a nearby sink.

General Electric scientist tests emergency laboratory shower without getting wet. (All cuts courtesy of General Electric)

Science Moves Sideways

Westinghouse Electric Corporation has disclosed a gas turbine locomotive with wheels that not only turn to negotiate curves but also move from side to side under the cab for smoother riding. The experimental locomotive, which has completed more than 60,000 miles of operation on six railroads, is declared to be the first gas turbine passenger unit to be operated in the United States. It is an eight-axle, single-unit locomotive, weighing 247 tons, powered by two 2,000-horsepower gas turbines with an electric transmission. It has a maximum speed of 100 miles an hour, and during its test runs it pulled trains averaging 26 to 29 cars in length.

The radically new type of locomotive running gear consists of four two-axle trucks. Each of these trucks not only swivels in the usual fashion when rounding a curve, but also moves laterally under the cab of the locomotive. A roller carriage is attached to each truck, and the cab of the engine rests on the rollers of the four carriages, thus permitting lateral motion.

Though consuming approximately twice the amount of fuel that diesel locomotives use, the price of residual oils has been below half of that of diesel oils.

Geared to the Job

Gears for driving a highly-sensitive solar telescope consuming less than a watt of power or for driving an ocean liner that uses thousands of horsepower can be cut on precision machines at the Westinghouse plant in Sunnyvale, California. A tiny gear, a half inch long and weighing less than two ounces, will drive one of the two largest coronagraphs ever built. The instruments "black out" the face of the sun to permit studies of its halo-like corona and prominences. In contrast the normal gear is 12 feet in diameter and weighs more than 21 tons —400,000 times as heavy as the midget gear. It's a "bull" gear that will drive the propeller of an ocean vessel. Its teeth must be cut accurately to within three ten-thousandths (3 10,000) of an inch.

It's Tough to Maintain a Vacuum

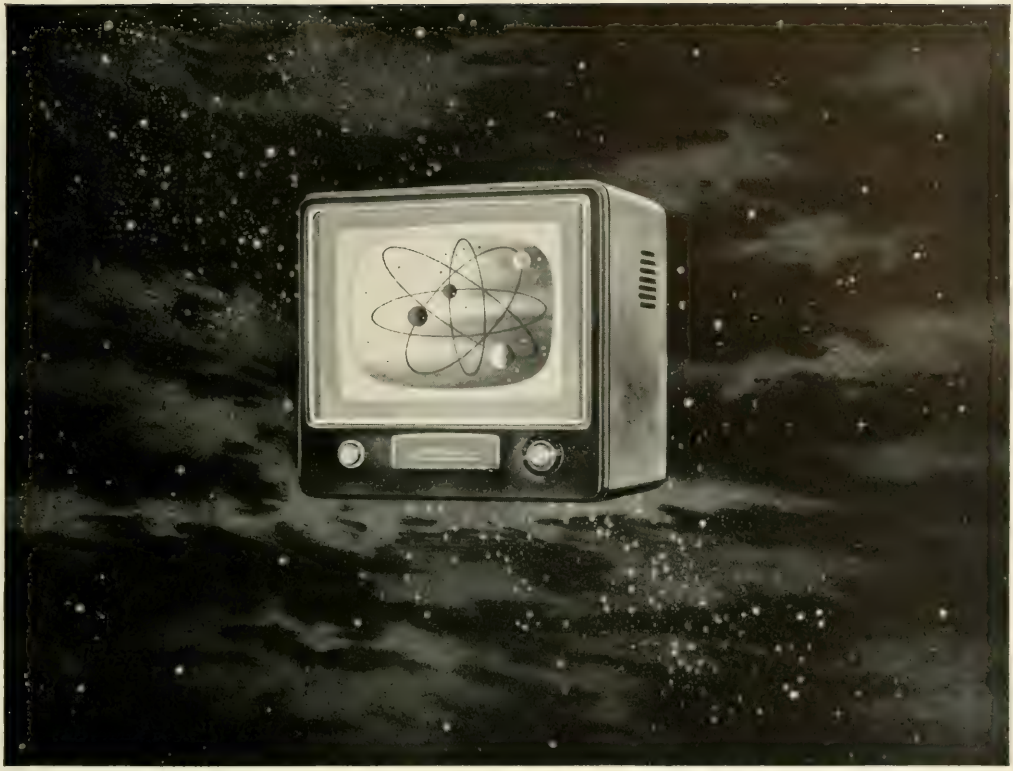
Scientists at the General Electric Research Laboratory at Schenectady, New York, are worrying about leaks so infinitesimal it would take 10,000 years to empty the contents of a pint bottle.

G. E. weather balloon whose instruments radio data to earth.

It is now believed that hydrogen and other gases can seek their way through solid glass and metal at these slow rates. These tiny leaks are sufficient to spoil vacuums used in scientific research.

Investigations have revealed that gases differ in their ability to permeate various barriers. These very small permeation rates were accurately measured

(Continued on page 26)



Basic research and engineering advances make RCA Victor's 1953 TV receivers the finest you can buy.

First with the major advances— since Television began!

Families living in television areas have seen from the beginning why more people buy RCA Victor television sets than any other brand. As television spreads to new communities, millions more learn the same.

Enthusiastic reception of the 1953 RCA Victor sets proves that advanced research and engineering means finer TV. You see it in the new "Magic Monitor" circuit system which *automatically* screens out interference, steps up power, tunes the best sound to the clearest picture.

Further proof of this leadership is the new RCA "Deep Image" picture tube with its micro-sharp electron beam and superfine phosphor screen which ensures the finest picture quality. It is also seen in reception at a distance—as well as in *automatic* tuning of all channels, both VHF and UHF.

Today's RCA Victor receivers result from the same research and engineering leadership that perfected the *kinescope* picture tube, the *image orthicon* TV cameras, reflection-free metal-shell picture tubes – and which opened UHF to television service.

* * *

RCA research assures you better value—more for each dollar you invest – in any product or service of RCA and RCA Victor.

CONTINUE YOUR EDUCATION WITH PAY—AT RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists

RCA® RADIO CORPORATION OF AMERICA

World leader in radio—first in television

SKIMMING . . .

Continued from page 24

by means of an instrument known as the mass spectrometer.

Helium filters easily through glass and plastics, but fails to penetrate metals in any measurable quantities. Hydrogen quickly invades iron, palladium and other metals, as well as glass and plastics. Nitrogen penetrates steel, but is effectively contained by copper. Oxygen slips through silver with comparative ease.

A gas penetrates through a solid in three easy stages. First, gas molecules strike the surface of the solid and form a thin film over it. Next they migrate into the material to form a solution inside the solid. After dodging through the solid's molecules, the gas molecules emerge on the vacuum side of the solid, evaporate and enter the vacuum space.

Weather Pen

With the aid of a radioactive point on a slender shaft mounted atop the G-E Research Laboratory, scientists are gauging the electrical activity generated by weather changes as slight as shifting winds. Even variations in intensity of light reflected from clouds sometimes register noticeable changes on the recording mechanism.

Electric current, collecting on the radioactive point from high potential developed between earth and atmosphere, is measured by an extremely sensitive G-E photoelectric recorder located in the laboratory's penthouse weather station.

A positive reading usually indicates cold fronts, freezing, and sublimation, while a negative reading usually identifies thunderstorms, warm fronts, melting, and condensation. Lightning flashes reverse the pen.

This weather device may be used in the future for closer pin-pointing of cold and farm fronts, to indicate the presence of fronts high in the atmosphere, to count lightning flashes in the area, to ferret out isolated showers, and to tip off weather men about the presence of disturbances which could be found otherwise only by radar. The G-E device costs only a fraction of the price paid for radar equipment.

Smoothies

A super-smooth, dust-free surface, the type a housewife dreams about, is being sought by scientists at the General Electric Research Laboratory at Schenectady, N. Y. The surface is needed for tests to determine why various insulating materials break down under high electric voltages. These investigations require electrodes free from invisible bumps and the tiniest dust specks.

According to one of the scientists, one speck may cause the breakdown voltage to vary as much as 10,000 volts on successive tests.

As the first step in the search for this ultra-smooth surface, stainless steel was polished mechanically to a gloss that outshone highly-burnished silver and chrome by use of polishing powder composed of particles measuring only one-millionth of an inch in diameter.

But since even this steel was too uneven, the scientists turned to liquids, choosing mercury as most suitable. It proved an excellent electrode and had a surface smoother than highly-polished telescope reflectors, but the mercury surface distorted under an electric field.

Recently, the scientists turned to glass as a near approximation of a liquid surface. Then they coated the glass with vaporized gold. The result was the smoothest solid surface found.

To make certain the surfaces remain clean during experiments, a laboratory staff member keeps constant watch through a microscope.

Even though the electrodes are stored under tightly fitting plastic covers, the careful G-E scientists scrub the surfaces just before use with a camel's hair brush dipped in a detergent.

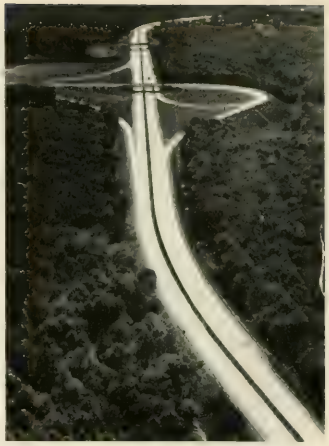
SUPERHIGHWAYS . . .

(Continued from page 13)

Newark and another crossing of the Hackensack River, engineers decided the road should be built over this marsh. The New Jersey Meadows consist of mud and silt deposits which are very high in water content. These deposits vary in depth from but a few feet to as much as 250 feet. Before the road could be built, this land had to be stabilized so it would support the road and its load.

The operation used in stabilizing the marsh was comparatively simple but required enormous amounts of time and material. The first stage in this operation was the placing of rectangular steel or timber settlement platforms on the marsh. Over these platforms, enormous volumes of sand were deposited. Drain holes were dug nearby the roadbed to depths of nearly 100 feet and were filled with sand. These sand drains allowed the marsh water to escape from beneath the road bed. Overload material was then placed over the sand in the bed. This literally squeezed the water from the underlying land. This process was continued until the marsh land could support the necessary weight. Then this overload fill was removed and the road constructed in its place. The cost of construction over this marsh land could support the necessary weight. Then this overload fill was removed and the road constructed in its place. The cost of construction over this marshy area was well over one million dollars per mile.

Traffic moves down the Turnpike in Central New Jersey.



One of the 24 traffic interchanges on the Pennsylvania Turnpike System.

With the success of both the Pennsylvania and New Jersey Turnpikes, other states have come into the picture for recognition. Maine, New Hampshire, New York, Connecticut, and Oklahoma all have an expressway completed or being constructed. Eleven more states have reached the advanced planning stage, among them are Illinois, Indiana and Ohio who plan to connect with the western terminus of the Pennsylvania Turnpike. Even Iowa has a committee studying the toll road problem.

Many states are rapidly realizing the need for superhighways in relieving their traffic problems. They are building with an eye for the future. With the great annual increase of highway traffic, superhighways will soon become the common servant of the motorists.

ME...
an AIRCRAFT engineer?

But I haven't majored in aeronautical engineering

That doesn't matter. Lockheed can train you... at full pay!

It's your aptitude, your knowledge of engineering principles, your degree in engineering that count.

Those—plus the opportunity Lockheed is offering you—are all you need for a career as an aircraft engineer. In Lockheed's special program for engineering graduates, you may go back to school, or you may convert to aircraft work by doing—on-the-job training. But whichever it is, you receive full pay while learning.

But Lockheed offers you more than a career. It offers you a new life, in an area where living conditions are beyond compare. Outdoor living prevails the year-'round. Mountains, beaches are an hour from Lockheed.

See your Placement Officer today for the details on Lockheed's Aircraft Training Program for engineers, as well as the better living conditions in Southern California.

If your Placement Officer is out of the illustrated brochures describing living and working conditions at Lockheed, write M. V. Mattson, Employment Manager.

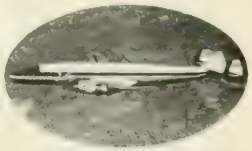
Lockheed Aircraft Corporation

Burbank, California

This Plane made History

The P-38 Lightning—first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History



The Super Constellation—larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

This Plane will make History

The jet of the future—the plane you will help create—belongs here.

This plane—which exists only in the brain of an engineer like yourself—is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.

ENGINEER . . .

Continued from page 15

Research and engineering are the back bone of our progress, which has put our standard of living far ahead of the rest of the world. And we're just beginning. Population is increasing, industry is expanding faster than ever before, and the need for engineers grows even greater.

Scientific knowledge and engineering "know-how" also have their place in the military picture. Modern warfare with its atomic bombs, guided missiles, radar and electronic controls calls for an army of specialists. Engineers are necessary in industry for the production of these weapons, and they are also much in demand by the Armed Forces. That doesn't mean that the engineer will be called into service any sooner than the untrained man, but he will have more opportunity for interesting jobs there.

In general, it looks as though engineering graduates will be a much sought-after group for some years to come.

Are there opportunities to get ahead?

Yes. Engineering training is not an automatic guarantee that you will become a company vice-president or a millionare. There are engineers who are not business successes, just the same as in every other profession. It is up to the individual to get ahead by his own efforts. But few people have blamed their lack of success on the fact that they had engineering training.

Right now the average engineering graduate is getting a job with the larger companies at a salary ranging from $300 to $400 a month. Whether this will go up or down in future years is anybody's guess. But disregarding starting salaries, past experience indicates that engineering training plus hard work and ability may lead to real success later on.

A recent survey found that 40 per cent of the top jobs in industry are now held by engineering trained men. Many top positions held by scientists and engineers are not technical ones. Numerous men in the fields of sales, advertising, personnel and other lines have engineering degrees, and most of them will say that their training has been extremely useful. Not only the technical knowledge helps. It's the thinking habits and the methods of analyzing a problem that become second nature to an engineer.

How can I tell whether I should take engineering?

As in almost any profession or occupation, there isn't any sure way of telling whether someone is cut out to be an engineer until he has actually tried it. There are a few signs, however, that often appear during high school to give some indication of a natural aptitude for engineering. Some of the best engineers showed none of these early indications, and some who showed them very clearly turned out in later life as something quite different, but they can be used as a very rough guide.

The prospective engineer is interested in mechancial things, likes to build model planes and trains, tinker with doorbells and radios. He likes to find out not only *how* they work, but *why*—and then try to improve them. He likes to read magazines and books on scientific subjects and keeps up on new developments—atomic power, jet propulsion and color television. He works out ideas on paper, making sketches and drawings before putting these ideas into material form, enjoys visits to factories and shops, and welcomes trips to scientific exhibits and museums. He usually does pretty well in his math courses, and may like to work with figures and geometric forms.

Those are some indications, but don't let them frighten you if they don't happen to fit your case.

Must I take special subjects in high school?

There are certain subjects you must take to qualify for most engineering schools, but these are not necessarily "special." The main objective in high school is to lay a firm foundation for your college courses. The fields of engineering overlap, and the same preparation will do for all of them. Later on in college will be soon enough to specialize and pick your particular branch.

Plan to take *all* the mathematics you can in high school. Some people find it easier than others, but it doesn't take any special genius to learn all the mathematics you need.

Taking both physics and chemistry will give you a head start and make your freshman year in college easier. The many formulas in physics and chemistry can be boring if you just memorize the symbols without thinking of what's behind them. Mathematics is a tool the engineer uses just as a carpenter uses his saw and hammer. The scientists who developed such things as our new plastics, jet engines, synthetic fabrics and synthetic rubber did as much with formulas on paper as they did with test tubes. You will probably not start out in high school developing some wonderful new product, but you will learn some of the ground rules that have to come first.

And don't neglect your English. It's always hard to convince a student—high school or college—that English is necessary to an engineer. But it is extremely important. It helps in his day-to-day work, and may be the *deciding* factor when it comes to promotion to an executive position.

Such courses as shop, drafting, economics, speech and history will make it easier for you later on. In some colleges a foreign language may be required for certain courses.

If you are not planning on going to college, or haven't made up your mind yet, this general type of high school course is still a good one. Mathematics and the sciences provide an excellent background for hundreds of jobs in modern industry. There are many technical positions which do not require a complete engineering course, but which do involve problems where mathematics and scientific analysis must be used. Even a salesman has to be able to figure out his commission.

Consult your parents, teachers and counsellors for further advice and guidance in planning your personal high school course. They have a real interest in you and are acquainted with what type of work you do best.

What is the next step?

Next start giving consideration to a choice of engineering college. There are about 150 in the United States. You will want to consider which ones best fit your particular interests, and of course the geographical location may be an important factor. But write to several of them for their catalogue of courses, entrance requirements, tuition, etc. This will give you a double check on what you should take in high school, and will also give you a glimpse of what is ahead of you in college.

You have often heard that going to college is pretty expensive. Of course it does cost hundreds of dollars. But today there are cooperative courses, scholarships and awards available, and almost anyone who really wants an education and is willing to work for it, can manage it in some way.

As to what is ahead of you beyond college, that is up to you. The opportunity is there. The world will always need good engineers and scientists and we hope that engineering will prove the right road for you.

Teacher: "In what battle did General Wolfe cry, 'I die happy'?"
Johnny: "His last one."

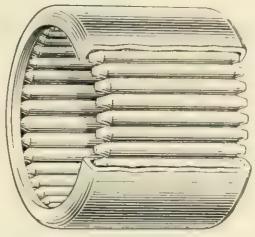
* * *

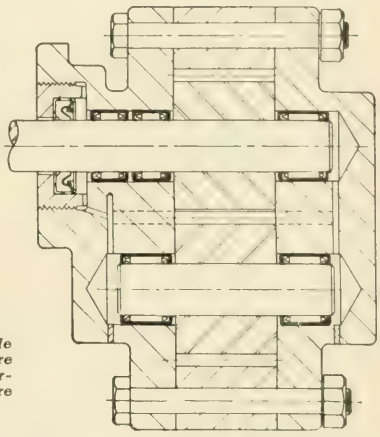
Now I lay me down to sleep,
The lecture's dry, the subject's deep;
If he should stop before I wake,
Someone kick me, for goodness sake.
—*The Kentucky Engineer*

The Torrington Needle Bearing

proper housing design is essential to proper performance

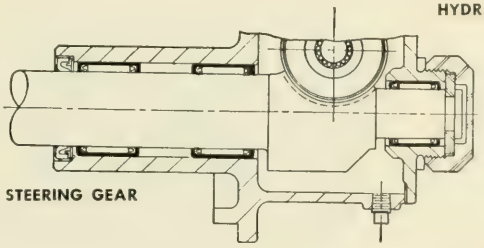
The Torrington Needle Bearing offers many design and operational advantages for a great variety of products and equipment. For example, a Needle Bearing has greater rated radial load capacity in relation to its outside diameter than any other type of anti-friction bearing. It is extremely light in weight. And it is easy to install and lubricate.





HYDRAULIC PUMP

Needle Bearings require simple housings. If the housing bores are held to proper size, accurate operation and high radial capacity are assured.



STEERING GEAR

Housing Maintains Bearing Roundness

The housing is an essential part of the Needle Bearing assembly. Care should be taken to provide a straight, round housing bore to the recommended tolerances.

The thin, surface-hardened outer shell of the Needle Bearing acts as the outer race surface as well as a retainer for the rolls. This shell assumes the shape of the housing into which it is pressed. Consequently, the housing bore should be round, and the housing so designed that it will carry the radial load imposed on the bearing without distortion.

Housing Material Determines Bore Size

The specified housing bore dimensions for any given material should be maintained in order to give the proper running clearance between the needle rollers and the shaft, and to assure sufficient press fit to locate the bearing firmly.

When designing housings of materials that are soft or of low tensile strength, allowance should be made for the plastic flow of the material when the bearing is pressed into place. Bore dimensions in such cases should be less than standard. Needle Bearings can be pressed directly into phenolic or rubber compounds, although metal inserts are recommended.

The new Needle Bearing catalog will be sent on request.

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NEEDLE · SPHERICAL ROLLER · TAPERED ROLLER · STRAIGHT ROLLER · BALL · NEEDLE ROLLERS

PLANNING THE RIGHT ANSWERS

The complexity of modern air defense—extreme aircraft speeds, highly complex weapons, new combat strategies, the advanced state of today's technology—poses serious problems for the scientist and engineer.

One significant solution lies in the extensive use of airborne automatic equipment, including electronic digital computers, to augment or replace the human element in aircraft control.

At Hughes Research and Development Laboratories

Dr. E. C. Nelson (left), Head of Computer Systems Department, and J. H. Irving, Head of Systems Planning and Analysis Department, discuss a problem in the systems planning and analysis stage.

each problem is attacked basically, beginning with systems planning and analysis. This consists of an exhaustive examination of the requirements of a problem, together with an evaluation of the best means for satisfying these requirements. The objective is to design the simplest possible mechanization consistent with a superior performance.

These techniques, employing many special talents, are responsible at Hughes for the successful design, development *and* production of complexly interacting automatic systems for all phases of electronic control of interceptor navigation, flight control, and fire control. Similiar accomplishments may be pointed to in the guided missile field.

Methods of systems planning and analysis responsible for achievements in the military area are also being applied at Hughes to adapt electronic digital computer techniques for business data processing and industrial controls.

HUGHES

Research and Development Laboratories

CULVER CITY,
LOS ANGELES COUNTY,
CALIFORNIA

PHYSICISTS AND ENGINEERS

Hughes activities in the computer field are creating some new positions in the Systems Planning and Analysis Department. Experience in the design and application of electronic digital computers is desirable, but not essential. Analytically inclined physicists and engineers with a background in systems work are invited to apply.

ADDRESS:
SCIENTIFIC
AND ENGINEERING
STAFF

Navy Pier

Power and more power that seems to be the theme in Detroit. Apparently the auto industry is in a mad dash to see who can produce the car with the most horsepower.

Currently, Lincoln is out in front with its 205-bhp. engine, but it will soon drop into second place when the 1953 Cadillac is unveiled in New York at General Motor's Waldorf-Astoria show. These massive monsters are powered with 210-bhp. engines. Cadillac's lead will be short-lived, however, for soon after that Chrysler plans to reveal its "Firepower Engine" with 220 bhp.

When will this merry-go-round stop? Even though many automotive people do not agree with this type of competition, there are others who believe that it has a good merchandising effect on the general public. Experts agree that these power increases are made with a keen eye toward sales. In our modern today, the public seems more speed conscious, the increased horsepower appealing to the average car driver.

As far as styling is concerned, the trend seems to be toward the sports convertible. Most major companies will have a model along this line before the year is out. There will be certain basic characteristics that each of these cars will have. All models are expected to feature wire wheels (currently on some present models of the Hudson), also power steering and brakes. In body styling there is much experimental work tending toward the Italian design; cars will be built lower.

In the accessories field the latest fad is air-conditioning, especially prominent in the General Motors family. Buick, Olds, and Cadillac will have it available, and other firms are expected to follow suit before the summer.

*Motor Trend** offers the latest news on General Motors' air conditioning. Buick cites a cold capacity of 32 average-size home refrigerators. Housed on the shelf in the trunk compartment, the unit filters cool air into the passenger area through ducts above the window, with over 300 cubic feet of air capacity per minute; this gives a complete change of air every 20 seconds. Outside air drawn into the unit is cleansed of pollen and all foreign matter before reaching the interior of the car.

The air conditioner utilizes the principle of evaporation for cooling, using the liquid Freon-12 in the system. As air passes over the unit's coils, evaporation of the agent occurs and heat is absorbed. The vapor then circulates throughout the system, eventually being transformed back into a liquid by a compressor and condenser mounted in the engine compartment; thus, the coolant never diminishes.

In a look toward the future, we see that the fiber-glass body will come into wide use. This prediction is based on the completion of Buick's latest experimental sports convertible, the Wildcat, equipped with a fiber-glass body.

Ivan L. Wiles, General Manager of Buick, stated that, "The use of molded fiberglass eliminates the need for expensive dies in manufacturing and may lead to greater versatility in designing sports cars." We predict that fiberglass may lead to great advancement in the automotive industry; besides versatility in design at cheaper cost, bodies can be made lighter and stronger; new, inexpensive dies will enable companies to put out more numerous models.

All this progress in the development of speed and design means more problems for the engineer. Power—Weight — Velocity — Highways — the whole picture needs appraisal if we consider *safety* the primary factor.

*"Spotlight on Detroit," *Motor Trend*, Vol. 5, January, 1953.

The Dry Lab . . .

by RICHARD ZMICH, E. Physics, '56
and CHARLES LaROBADIER, M.E.,'55

Bubble Bath at Rose Poly

On Monday, October 26, the senior mechanicals were running an office experiment in the Fluids Lab. The men were in position to read their gages. The pump was started; then it happened. Soap bubbles started to fill the lab. After the motor was shut off, a few intelligent individuals tried to wash the suds away with a hose. This only got them more suds. The pump was started again to see what effect it would have Again, more suds resulted. By this time there were several cubic feet of suds (an estimate of 5000 cu. ft. has been heard) and more still available. Thus, the long-thought-of practical joke had been carried out.

Cleaning out the bubble bath in the fluids lab. (Cuts and story courtesy Rose Technic)

After all the suggested solutions were considered, the decision was reached to drain the whole system and refill it. All 7000 gallons of water were removed. Three thousand gallons were used to flush it out, and 6000 gallons were used to refill the system. Five hundred pounds of borax had to be added to the water.

This incident was humorous to the innocent by-standers, but to the two men who spent all day Saturday cleaning up the mess it was not as funny. The joke was fairly expensive when the price of water, borax, and labor are considered.

All of this was not wasted, however. In cleaning out the water, two fountain pens, a pound of mercury, and two pennies were found. All the soap certainly must have cleaned the place somewhat, and think of the sweet odor the lab must have. The soap in the pipes will also give the mechanicals another boogy factor to add to the books full they have already.

Want $500?

$1,000 in Scholarships Now Available for Students in Sanitary Engineering.

The N. O. Nelson Company has donated to the University of Illinois two $500 scholarships under the following terms:

"Available to seniors who are in the engineering curriculum whose courses would qualify them to graduate as Sanitary Engineers and requiring the recipient to carry on courses of chemistry during the senior year that would better fit him to the understanding of chemical

(Continued on page 36)

What Are These Spheres?

- ☐ *Catalyst Supports*
- ☐ *Moth Balls*
- ☐ *Abrasive Grains*

They are catalyst supports — Norton refractory products made of chemically inert, heat-resistant, wear-resistant materials for use as catalytic carriers in chemical processes. Pictured in spherical shape here, they are also available as pellets and rings.

Composition and Properties

These supports are commercially available in ALUNDUM* (fused alpha alumina) mixtures varying from 77% to 89% alumina with silica as the principal impurity. In addition to their refractoriness, they are chemically inert, mechanically strong and wear-resistant

Water absorption values of these supports vary from 12% to 22% by weight. Surface areas by the nitrogen absorption method range up to about one square meter per gram. Crushing strengths vary from 20 to 600 pounds, depending on size and shape, and bulk densities range from 60 to 80 pounds per cubic foot.

Many Refractory Products

Catalyst supports are but one of many refractory products made by Norton. These include small furnace refractories such as tubes, cores and muffles; large furnace refractories such as bricks, plates, muffles and other shapes; refractory cements; refractory laboratory ware; kiln furniture for ceramic plants.

In its search for refractory products that can be used at higher and higher temperatures, Norton has developed a line of pure oxide refractories. These refractory shapes, as their name implies, are molded without bond and then fired at sufficiently high temperatures to produce a truly sintered product.

The principal raw materials used in the manufacture of Norton pure oxide refractories are ALUNDUM (fused alumina), MAGNORITE* (fused magnesia), fused stabilized ZIRCONIA and, to a limited degree, fused thoria.

Planning Your Future?

Norton Research is continually developing better products to make other products better. Young technicians who are interested in contributing to the technical advances of the future will find Norton Research well worth investigating.

Free Booklet on

longer lasting Norton refractory products contains detailed descriptions of Norton contributions in this field. Write for your copy.

Norma L. Gullberg, A.B., Chemistry, Clark University '46, takes a reading with an optical pyrometer on a high temperature furnace used for catalyst support tests.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

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TRADE MARK REG. U. S. PAT. OFF.
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ABRASIVES · GRINDING WHEELS · OILSTONES · ABRASIVE PAPER & CLOTH
REFRACTORIES · POROUS MEDIUMS & LABORATORY WARE · NON-SLIP FLOORING
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BEHR-MANNING, TROY, N. Y. IS A DIVISION OF NORTON COMPANY

DRY LAB . . .

(Continued from page 34)

reactions present in the biological treatment of sewage."

It is expected that one scholarship will be awarded this semester to a senior student registered in the sanitary engineering curriculum and that another scholarship will be awarded a different student next semester. Recommendations of the recipient of the one scholarship for this semester will be made by the civil engineering department sometime in March, the exact date yet to be specified.

Eligibility, beyond the requirements stated in the gift to the University, will be based on scholarship, extra-curricular activities both professional and otherwise, personality, leadership, and financial need. Applications for this semester's scholarship should be addressed to Professor W. C. Huntington. The applications should be in his office not later than the date which will be stated later. Notices of the due date will be published in the office of Professor H. E. Babbitt and the main bulletin board, both in the Civil Engineering building.

The application should be accompanied by information concerning the applicant's qualifications as listed among the requirements for eligibility, other than scholarship at the University of Illinois. The application should be accompanied by the names and addresses of at least three qualified persons from whom information concerning the applicant's character and experience can be obtained. The appearance, wording, and contents of the letter of application may have considerable bearing on the selection of the recipient.

Come North

This is an appeal—an appeal to you, the high school student who may be considering engineering as your profession.

As a student who has chosen it as my field of endeavor, I urge you, in behalf of the profession and of science in general, to think seriously over your possibilities in a scientific field. Every type of engineer is desperately needed to alleviate the acute shortage the nation now faces, and this deficiency threatens to grow. In June of 1951 there were 38,000 graduates and 80,000 jobs. The military claimed 19,000 through the R.O.T.C. leaving less than 20,000 men for civilian openings, or four jobs for every graduate. With the recent fluctuations in college enrollment, an accurate prediction is difficult. However, it can safely be estimated that four years from now there will be three opportunities for every graduating engineer. This situation will not only provide the graduate with a choice of jobs but it also spells better wages.

All this makes engineering sound like a wonderful profession, which it certainly is. The interest, enjoyment and satisfaction to be obtained from it is invaluable. Every day of an engineer's life is different; new problems, new ideas and a new challenge arise daily to be met by the engineer.

In 1674, Sir William Petty had this to say of engineering: " . . . 'tis the profession of the society, to make mysterious things plain; to explode and disuse all insignificant and puzzling words; to improve and apply little threads of mathematics to vast uses; and yet not to neglect the finest consideration, even of atoms, where the same is necessary."

Since Sir Petty's time, however, engineering has grown tremendously and it has been subdivided into many phases. The University of Illinois offers degrees in all these particular types of engineering. Each is a separate field in itself and will be described to give some idea of what it involves.

Aeronautical Engineering. This curriculum is primarily to "train students in the basic principles of airframe and aircraft power plant design and construction." Elective courses allow the student to specialize in aerodynamics, aircraft structures, aircraft power plants, design, and production.

Agricultural Engineering. Agricultural engineering includes the same basic courses as other engineering curricula and also fundamental agriculture courses. Options include either machinery and power option, dealing with mechanical engineering design courses and advanced work in farm and machinery design, or farm structures, soil and water engineering option which includes civil engineering design and agriculture courses in farm structures and soil and water engineering.

Ceramic Engineering. Concerned with the utilization of non-metalic minerals, ceramic engineering deals with the manufacture of brick, tile, pottery, refractories, glass, porcelain enamels, abrasives and cements. It includes investigation of the properties of ceramic materials, manufacture, design, and erection of equipment, research and engineering service in the sale and uses of ceramic materials, products and equipment.

Chemical Engineering. These courses prepare the student to transform laboratory results to large scale commercial processes, to improve present plants, to develop new products and equipment; and to operate and supervise chemical plants. It deals with chemistry, mathematics, and physics and their industrial application.

Civil Engineering. Civil engineering offers training in the design and construction of bridges, dams, buildings, retaining walls, foundations, highways, water supply and sewage disposal systems and hydraulic engineering works. Specialization is possible with construction, highway, hydraulic, railway and structural options.

Electrical Engineering. Electrical engineering courses train men for research development, design, operation, sales and administration in electrical power, communication and electronic engineering, and illumination. Options in electrical power engineering, communication and electronic engineering, and illumination engineering give the student a choice of specialization.

General Engineering. This curriculum combines a sound education in engineering principles and their application,

(Continued on page 52)

Bubble bath in the fluids laboratory at Rose Polytechnic Institute.

THE DU PONT DIGEST

John Purdom, *B.S. in Ch.E., Ohio State '49, and* **Kenneth Kehr,** *North Carolina State '50, discuss diagram of a process for improved recovery of an intermediate for high polymers.*

THE ENGINEER'S PLACE IN

Plant Development

Another phase of Du Pont production activities offers challenging work for the technical man

E. H. Ten Eyck, Jr., *B.S. in Ch.E., Syracuse '43, Ph.D. in Ch.E., Brooklyn Polytech '50, and* **W. H. Stevens, Jr.,** *B.S. in Ch.E., Yale '50, take recordings on a new nylon unit.*

D. S. Warner, *B.S. in M.E., Purdue '47, and* **G. R. Prescott,** *B.S. in Met. E., Columbia '49, discuss improvements for stainless steel liners in tubes carrying corrosive materials.*

In most Du Pont manufacturing plants you'll find two groups of engineers working side by side to make operations more efficient—to reduce costs and improve quality. The specialized work of one group, the production supervisors, has been rather fully discussed in the *Digest*.

Equally vital is the work of development men—the men responsible for advising management when operational changes should be made for economic or technical reasons.

Engineers from several fields of training are employed in development activities at Du Pont. It seems to have a special appeal for the man who can take on a big problem, analyze its parts, and come up with a thoughtful, reasoned solution.

Individual development studies may begin in a number of different ways. Often they are sparked by the imagination of the engineer himself, who, of course, must be familiar with production costs, activities of competition, and recent or impending technical improvements.

Studies also may be inspired by suggestions of production supervisors or sales personnel, obsolescence of equipment, advances in competitive products, or the presence of unsatisfactory profit margins.

In a single study, the engineer may draw data from laboratories, semiworks and plant-scale experiments, prepare an estimate of profits and investments and consult with numerous specialists on various phases of the problem, both within the Company and outside.

Having collected data from these many sources and perhaps from an independent study of his own, the plant development engineer must then assemble and evaluate the material and prepare a recommendation that is based on sound engineering judgment.

Whether a product or process improves from the standpoint of competition, profit and efficiency depends, in great degree, on the quality of its plant development work. The development engineer's job is a responsible one at Du Pont, and the work of a good man is soon noticed.

HAVE YOU seen "Chemical Engineers at Du Pont"? New book describes initial opportunities in many fields, tells how experiences are varied to prepare men for administrative and management positions. For copy, write 2521 Nemours Bldg., Wilmington, Delaware.

DU PONT

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When you are prepared to enter the engineering profession, consider the career opportunities at North American. In the meantime, feel free to write for any information you might want concerning a career in the aircraft industry.

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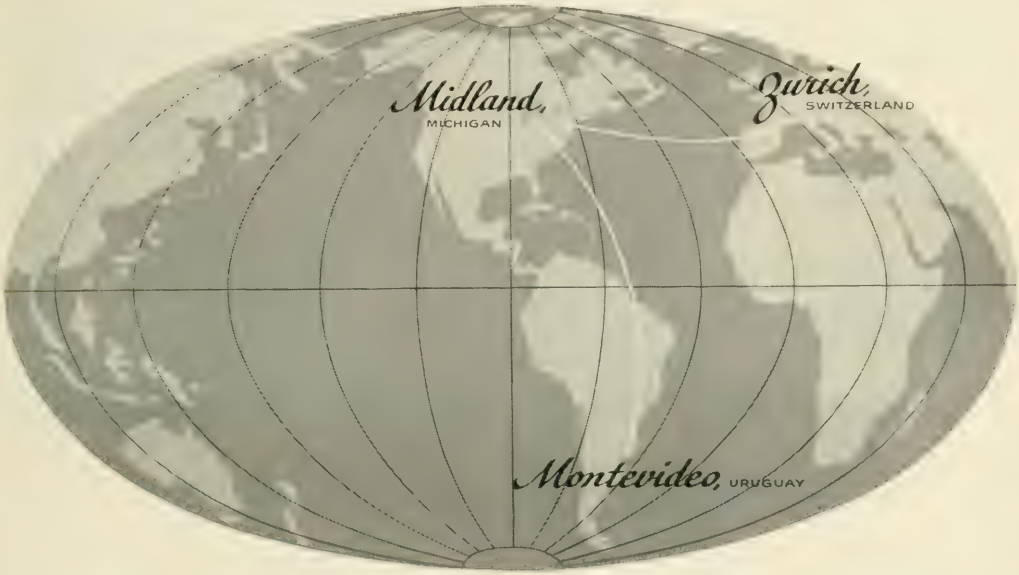
DOW

DOW ADDS NEW EXPORT COMPANIES

Dow has recently formed two subsidiary export companies to serve foreign industry's increasing demands for high-quality chemicals.



In the Western Hemisphere, Dow Chemical Inter-American Limited with sales offices in Montevideo, Uruguay will supply chemicals to Mexico and to many countries in Central and South America.

Industries in other continents—Europe, Asia, Africa, and Australia—will be served by Dow Chemical International Limited. Its first sales office will be in Zurich, Switzerland.

These two new export companies are only one example of the continued growth taking place at Dow. Each year finds new Dow plant facilities, increased production, new products developed . . . an over-all growth and expansion that requires a steady influx of men of varying talents, as well as providing excellent opportunities for those within the Dow organization.

Dow's Booklet, "Opportunities with The Dow Chemical Company," especially written for those about to enter the chemical profession, is available free, upon request. Write to The Dow Chemical Company, Technical Employment, Midland, Michigan.

you can depend on DOW CHEMICALS

DOW

ATOMIC ENERGY . . .

(Continued from page 17)

material for reactors which appears suitable so far as physical properties are concerned, we must now add still another requirement. The nuclear properties must be such that the structural materials will not capture neutrons and thus deplete the supply and reduce the power. This requirement drives us to consider strange new elements, and raises a whole array of procurement problems.

Even after we have our reactor working we find that the fission products produced as an essential part of the reaction "poison" the reaction itself. The ashes smother the fire.

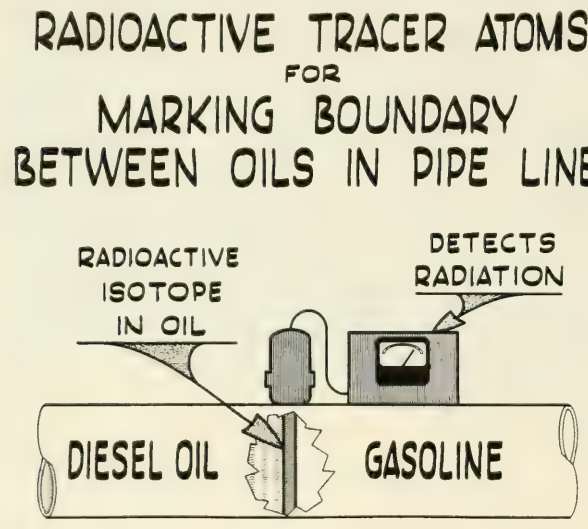
Finally, assuming that we have solved the structural problems, we have a whole new category of problems in connection with the working fluid or heat transfer medium used to convert the heat into power.

Radioisotopes—the tagged atoms

Radioactive isotopes, or just radioisotopes, for scientific, agricultural, and industrial use constitute the first great contribution of the development of atomic energy to peacetime welfare. Industrial power from nuclear energy may be a decade or more away, and most other applications are still largely speculative. But radioisotopes produced in the Nation's atomic energy establishment at Oak Ridge, Tennessee, are already at work in more than three hundred laboratories and hospitals in this country and abroad.

In explaining the production of radioisotopes, it is first necessary to review a few fundamental facts. The atom is composed of a nucleus surrounded by electrons which are negatively charged particles. The nucleus, upon which is based this new horizon of science, is composed of neutrons -which have no charge—and positively charged protons. When a neutron is added to the nucleus, the balance between the neutrons and protons may be upset and the resulting unstable nucleus emits radiation and becomes known as a radioisotope.

Since the best source of neutrons is the chain-reacting pile, radioactive isotopes can be produced by inserting small amounts of an element into the pile. The atoms of this element are subjected to a constant bombardment by neutrons from the fission process and a considerable number of the foreign neutrons are captured by the nuclei of the target atoms.



After a neutron has been captured by a target atom, the atom may become radioactive in one of several ways. Most commonly, a gamma ray is emitted. This type of radiation is similar to X-rays and has great penetrating power. Many radiosotopes also are produced by emission of a proton from the nucleus after the capture of the neutron. Since this changes the charge of the nucleus, a transformation has occurred and it becomes another element—usually radioactive. This process is known as a transmutation and is the method used to produce carbon 14. In the pile, nitrogen atoms present in the target material, calcium nitrate, are transmuted to carbon 14.

The tremendous advantage of the radioisotopes lies in the fact that while they are chemically identical with the stable forms of the elements, they are radioactive and their radioactivity can be detected. Thus a minute quantity of one of these isotopes can be followed through complicated chemical reactions, through the metabolic process in the body, through entire biological cycles or through other physical and chemical processes and still be identified. Dilutions or chemical changes of the tracer isotope make no difference. The radioactivity will still register on a Geiger counter or show its course on photographic film. The atoms are tagged for as long as the radioactivity lasts.

The rate at which radioactive materials undergo transformations is measured by time intervals called the half-life. At the end of the first half-life period the amount of radioactivity is half the original amount. In the next half-life interval, half the remaining activity — or one-fourth the original amount—remains. The half-life of different materials varies widely. For uranium 238, it is 4.5 billion years; for carbon 14, it is 5,000 years, and for radium 1,590 years. Radiogold has a half-life of 2.7 days. Radioactive potassium has a half-life of 12.4 hours, and a special isotope of polonium has a half-life of approximately one millionth of a second.

Tagging the Atoms

Broadly speaking, there are three ways in which neutrons in the pile produce radioisotopes; (1) by splitting atoms of fissionable uranium into new atoms of entirely different elements—fission products, so-called — which are radioactive themselves; (2) by being captured in the nuclei of atoms of special "target material" inserted into the pile, turning them into heavier isotopes of the same element; (3) by altering the electrical charge of the nuclei of atoms of target material, thereby transmuting them into isotopes of a different element.

Uranium fission products removed from the pile contain a great variety of radioactive materials, which—in method (1) above—can be extracted and purified by chemical means. However, the radioisotopes obtained are all those of elements near the center of the atomic scale between zinc (number 30) and gadolinium (number 64). With the exception of iodine, these do not enter significantly into medical, biological, agricultural, or most industrial processes. Therefore, most of the radioisotopes supplied by Oak Ridge must be prepared by methods (2) and (3). These call for the preparation and pile

(Continued on page 44)

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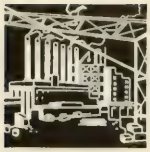

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The application of proved engineering principles to the day-to-day problems of operating the equipment used in the production, transmission and distribution of electric power.

• Sales and Customers Service

The promotion of increased sales by helping the consumer make the best use of the energy he buys, and by showing him how to let electricity do more of his jobs.

• Research

The investigation of problems which daily face any part of the production, distribution or sale of electricity, and making recommendations for their solution.

• Business Management

The coordination of problems related to Company finance, materials, property and personnel for the efficient operation of the business.

These are the five principal channels through which graduates may advance at The Detroit Edison Company. Under these broad headings are hundreds of different positions—all working together for the best interests of customer, employe, and investor.

When a graduate joins The Detroit Edison Company, he is assured every opportunity to fit into the job he likes best—and, once there, he knows he will be encouraged to advance as rapidly as his ability and energy will carry him.

Detroit Edison is a fast-growing electric utility company. It is foresighted, too. For example, already Detroit Edison engineers are working with Dow Chemical Company as one of the nation's four atomic research teams. Under investigation is use of nuclear heat in thermal electric generating plants, to produce electric power even more efficiently.

There's a future for graduates at The Detroit Edison Company—a career opportunity best described by the fact that many of the high ranking executives in the organization at this time began their climb to success in positions similar to those offered graduates today.

ANOTHER DETROIT EDISON STORY OF CAREER SUCCESS

Paul Murphy, Jr., received his BSME degree from Purdue in 1941. After four years of service as a Naval engineering officer, he joined Detroit Edison as a junior engineer in the Production Department and progressed in less than seven years to the position of Boiler Room Engineer in charge of all 12 boilers at Detroit Edison's Delray plant, a position of responsibility that includes the supervision of methods, procedures, and maintenance scheduling for boilers and coal handling equipment.

For the full story of your career opportunities at Detroit Edison, simply call or write for a free copy of this new booklet "What about the Electric Power Industry?"

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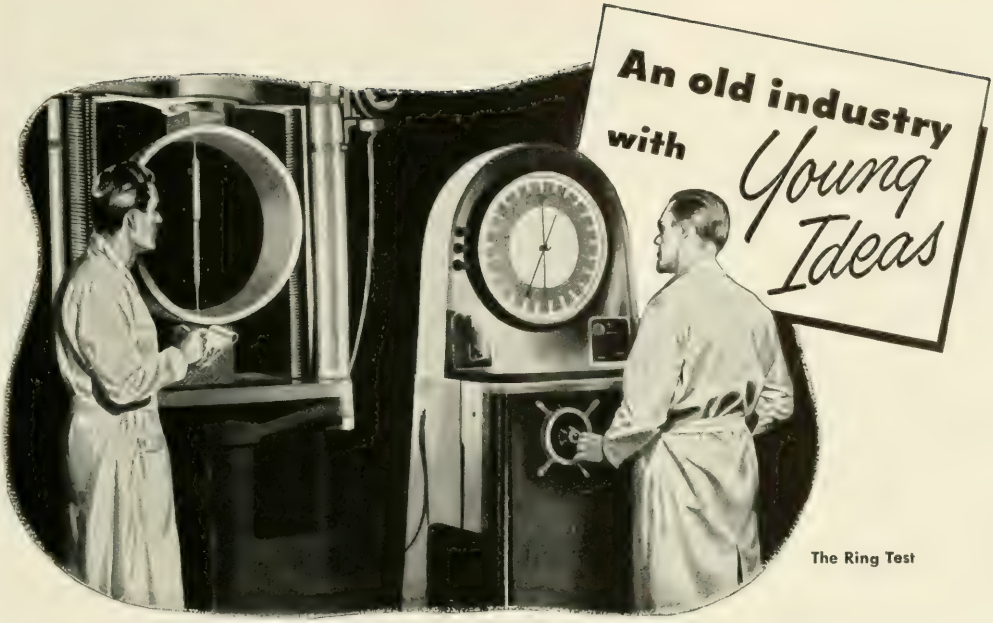

The Ring Test

The ring test, shown above, is a scientific method for determining the modulus of rupture of pipe. It is not a required acceptance test but one of the additional tests made by cast iron pipe manufacturers to ensure that the quality of the pipe meets or exceeds standard specifications.

A ring, cut from random pipe, is subjected to progressively increased crushing load until failure occurs. Standard 6-inch cast iron pipe, for example, withstands a crushing weight of more than 14,000 lbs. *per foot.* Such pipe meets severe service requirements with an ample margin of safety.

Scientific progress in the laboratories of our members has resulted in higher attainable standards of quality in the production processes. By metallurgical controls and tests of materials, cast iron pipe is produced today with precise knowledge of the physical characteristics of the iron before it is poured into the mold. Constant control of cupola operation is maintained by metal analysis. Rigid tests of the finished product, both acceptance tests and routine tests, complete the quality control cycle. But with all the remarkable improvements in cast iron pipe production, we do not forget the achievements of the early pipe founders as evidenced by the photograph below of cast iron pipe installed in 1664 to supply the town and fountains of Versailles, France and still in service. Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction. Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3, Illinois.

Section of 285-year-old cast iron water main still serving the town and fountains of Versailles, France.

CAST IRON PIPE SERVES FOR CENTURIES

ATOMIC ENERGY . . .

(Continued from page 40)

irradiation of special target materials. Phosphorous 32, a widely used radioisotope, can be produced by both methods and may be used to illustrate.

In the production of phosphorous 32 by "neutron capture," method (2), phosphorous 31, contained in phosphate, is put into aluminum cans which are set in holes in a graphite block and pushed into the center of the pile. Each atom of the stable element phosphorus 31 that captures a neutron becomes phosphorus 32. But not enough neutrons are present in "low flux" piles to convert more than a small proportion of the phosphorus atoms to the radioactive state. Hence the phosphorus 32 is still much diluted with phosphorus 31, and the treated phosphate is not highly radioactive.

In practice, therefore, phosphorus 32 is usually produced by method (3), "transmutation." This process starts with a target element different from the element of which an isotope is desired. Sulphur is the target for the production of phosphorus 32. Bombardment by neutrons in the pile changes the electrical charge of the nuclei of some of the sulfur atoms, and thus transmutes them into phosphorus 32. When the sample has been removed from the pile, the radioactive phosphorus can be chemically separated from the target sulfur. Phosphorus 32 in a very pure form, high in radioactivity, can thus be obtained. Unfortunately many of important radioactivity, those of calcium, iron, and zinc, for instance — cannot effectively be made by transmutation. They can be produced only by neutron capture, and this, as stated above, gives a product low in radioactivity. When a pile of higher neutron flux becomes available, it will be possible to produce radioisotopes of greater usefulness for research.

Handling the Radioisotopes

From the preparation of the target material to the final shipment of the product, the production of radioisotopes demands skilled personnel and special equipment. When the pile is shut down for the removal of the irradiated samples, each member of the team of workers must know precisely his assignment in the operation, and carry it out quickly and without error. Geiger counters and other radiation detection equipment must be used constantly to check up the radiation present. In subsequent chemical treatment of materials, the work must be carried on behind lead shields, the workers using tongs and mirrors to avoid exposure. Many chemical operations are conducted inside a "hot lab," a room with thick concrete walls in which apparatus is manipulated from outside by remote control devices, the chemist viewing his work through periscopes. Each radioisotope, moreover, is a separate production problem, involving its own combination of requirements—for target material, irradiation time, chemical treatment, safety precautions, and the rigid time limits associated with its inflexible half-life.

Radioactive substances, as mentioned before, are shipped by common carrier in specially constructed containers. Containers range in weight from less than a pound to a ton. The amount of shielding varies with the amount and energy of radiation. The average container, such as used for shipping the radioisotope of iodine (I 131), weighs between one hundred and one hundred and fifty pounds. The thickness of lead shielding varies from one-half inch, depending upon the amount shipped.

The radioactive material is first placed in a glass bottle which is inserted in an air-tight stainless steel cylinder. The cylinder, in turn, is placed inside a lead shield which is supported firmly inside a strong wooden box. Lead shields are placed inside the box which is then sealed for shipment. The box is finally checked with sensitive radiation instruments to determine the amount of radiation at the surface. Should this prove to be above tolerance, the substance is repacked with a thicker shield.

Perhaps one of the largest shipments of radioactive material was in February, 1947, when a twenty-three gram unit containing radioactive cobalt (Co 60) was shipped to the Bureau of Standards in Washington. The container, shielding the cobalt oxide which was equivalent in weight to a fifty cent piece, weighed sixteen hundred pounds. This isotope which has a half-life of five years is being used by the Bureau to furnish radiation standards to research workers for calibration of radiation measuring instruments.

Some of the most important radioisotopes for fundemental research in medicine have especially short half-lives. These include radiogold (three days), radioactive potassium (thirteen hours), radiosodium (fifteen hours), radioiodine (eight days), and radiophosphorous (fourteen days).

Shipments of these materials are handled as expeditiously as possible. When an order has been processed and a shipping date set, prior arrangements relative to shipment are made with an airlines agency and the shipment—after being properly packaged—is sent by fast truck to the air port just before flight time. Simultaneously the customer is notified of the departure time and advised to meet the plane at its destination and arrange for prompt delivery.

Putting Tagged Atoms to Work

The uses of radioisotopes are too numerous to be fully discussed in an article of this length. Therefore, I shall attempt to bring out only the more important uses in medicine, agriculture, and industry.

In Medicine

In hospitals today, physicians are using radioisotopes to diagnose various circulatory disorders, to locate malignant tumors, to measure how sick thyroid glands are functioning, to find out out how much iron the red blood cells of anemic patients can take up, and to diagnose various unhealthy internal body changes that they could not identify without the radioactive tracers to follow and report on the movement of materials in the body.

For example, by injecting a tagged salt solution into a patient's leg the physician, equipped with his detection instrument, can quickly tell if circulation is abnormal by the rate at which radiosodium is concentrated in the foot. The University of California Medical School reports diagnosing in this way more than two hundred cases of nineteen different types of disorders in the hands and feet. The diagnoses have been so reliable that they are used to determine whether or not it is necessary to amputate, and where to make the severance, if it is necessary.

Some malignant, abnormally growing tissues absorb certain elements in the body, such as phosphorous and iodine, faster than normal; others absorb certain elements more slowly than normal. Cancer specialists are taking advantage of this fact and using radioisotopes to help locate tumors. The University of California Medical School and the Cook County Hospital, Chicago, are using radiophosphorous to locate cancer in the breast; the radiations enable diagnosticians to distinguish between benign and malignant growths, since the latter take up phosphorous at a slightly greater rate. The University of Minnesota Medical School uses a radioiodine compound to determine the location of brain tumors as a preparation for operation, and reports the tracer technique as being more accurate and reliable than other methods.

Agriculture

In agriculture, the use of radioisotopes in research is expected to provide future dividends for the farmer. Radiophosphorous is being used to study the action of phosphate compounds in the soil. These experiments are intended to give information which will lead to improved fertilizers.

Radiophosphorous and radiochlorine are being used in fundamental studies on the movement, accumulation, utilization, and distribution of phosphate and

(Continued on page 48)

Preparing for specific responsible positions with Trane in sales, research and product design, these graduate engineers are attending a streamlined six-month training course at full pay. This interesting course moves rapidly and adapts the graduate's knowledge of engineering to the position he has chosen.

Trane Offers Engineering Graduates

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Those selected will join the Trane Graduate Training Program in La Crosse at full pay. Each man will receive a specialized course to assure personal success in the position he has chosen.

He will learn how Trane equipment is used in jet aircraft, tanks, submarines, ships, skyscrapers, factories, industries, homes and buildings of all types. He will see how rapidly air conditioning is becoming a necessity . . . how it is destined to become a standard requirement in homes, automobiles, schools, offices . . . everywhere.

Graduates move quickly into responsible, well paid positions. Men who joined the company through this training program include the president and numerous company officers, managers of most Trane sales offices and home office sales divisions.

Trane's record has been one of steady growth and leadership for nearly forty years, during both peace and war. Today, new Trane products are being developed constantly . . . creating new departments and promotions . . . assuring continued growth and business opportunities.

For an outstanding career in one of the fastest growing industries, consider your future in air conditioning with Trane. Write immediately to Milton R. Paulsen, Training Department Manager, for the brochure "Trane Graduate Training Program". Next six-month class starts in July.

WHAT OTHERS SAY ABOUT TRANE

How much can graduates of their training program earn? What about competition? Is Trane strong financially? Does the company offer outstanding opportunities to young men?

For the unbiased answers, read FORTUNE magazine's report on Trane in their August, 1951 issue. Your library should have a copy. A reprint of this report is included in the "Trane Graduate Training Program" brochure which is in your Placement Office.

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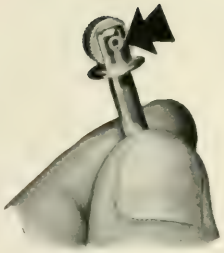
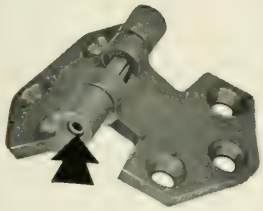
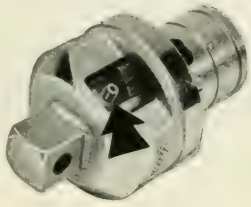


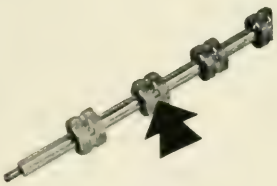
Replacing a rivet



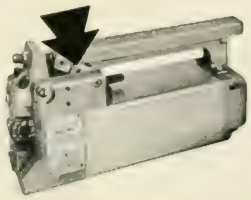
. . . a hinge pin



. . . a stop pin

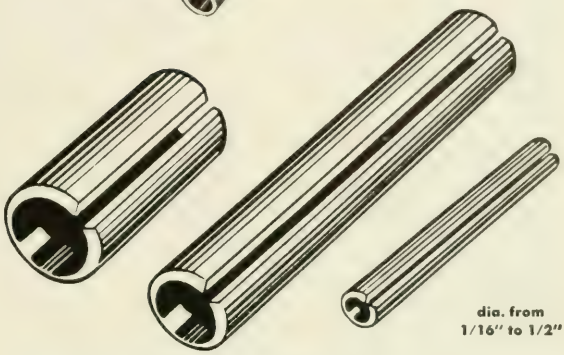


. . . a set screw



. . . a bolt and nut

ROLLPIN



dia. from 1/16" to 1/2"

. . . a modern fastener that saves time and money on thousands of applications

Rollpin is a hollow, split, cylindrically formed pin with chamfered ends. It is simply driven into holes drilled to normal production tolerances. Because Rollpin is slightly larger than standard sized holes, it compresses as inserted. It is self-locking—and vibration-proof—because of the constant pressure it exerts against hole walls. Its shear strength exceeds that of a cold rolled pin of the same diameter. Rollpin is readily removed with a drift or pin punch—and can be reused.

Because of its versatility—and the production economies it makes possible—Rollpin is finding wide usage in almost every phase of manufacturing activity. Write for design information on the Rollpin. It will enable you to cut costs for many applications where use of rivets, set screws, dowels, and straight, serrated or cotter type pins create installation or performance problems.

ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, New Jersey

Elastic Stop Nuts with the famous red collar are another ESNA product

ESNA

ATOMIC ENERGY . . .

(Continued from page 44)

chlorine in the growing plants. These studies not only include the uptake of phosphate and chlorine from the soil but also the plants response to these elements. The ultimate purpose of these investigations is to find out how to grow more and better corn.

At the Bureau of Plant Industry radiopotassium, radiorubibium, and radiocalcium are being used to study the soil chemistry of potash in particular the storage of potash in the soil. The radioactivity of the elements will make it possible to follow the movements of these elements into plants.

Radiocobalt is being used to trace plant material consumed by insects. The information obtained may enable the farmer to have more effective control of insect pests.

From these and many other tests it has been learned that potatoes use up phosphorus from fertilizer during their entire growth period, whereas corn, tobacco, and cotton take it up only during early growth. What that means to the farmer is that applications of phosphate fertilizer may be profitable for potatoes throughout the season, but useless for corn, tobacco, and cotton after early growth.

These newly learned facts about the use of fertilizer are to help manufacturers design new machinery for fertilizing. Plant breeders, too, are to benefit along with farmers and consumers.

Industrial

Among the actual research products using tagged atoms, few as yet are wholly textile, although many touch importantly on techniques and products used in the industry. Most of the few textile experiments already conducted or projected are in the fields of fabric finishing and primary rayon manufacture and are largely chemical in their nature.

The problem of gauging the thickness of extremely thin films has long been a headache in industry.

The average thickness of a sheet of Pliofilm, a Goodyear products, is about one-thousandth of an inch.

Mechanical gauges such as are now in use are difficult to use since the tiniest change in the pressure of the gauge on the film will give a false reading. Present gauges read with only dubious accuracy to a ten-thousandth of an inch.

The usual mechanical gauge compresses the film between a metallic foot and an anvil. The theory is that the weight of the foot will provide the same pressure but it is apparent that the softness of the film will affect the result.

Various refinements may be incorporated but one difficulty about using all such gauges in conjunction with a production line is that either the progress of the film must be halted for gauging purposes or a piece of film must be cut from the sheet and subjected to gauging.

The new radioactive gauge, using radiocarbon (C 14), makes it possible to gauge a sheet of Pliofilm or other film continuously as it comes from the rolls. No mechanical contact with the film is required.

The film passes through a slot in the gage. Below this slot there is a small bit of carbon 14. Above the slot there is an ionization chamber in which is produced a minute electrical current by the rays from carbon 14. This current is amplified by sub-miniature vacuum tubes to the point where it is sufficiently large to operate an ordinary electric meter which will then indicate the strength of the rays.

The strength of these rays is directly proportional to the number of electrons getting through the sheet of film. Consequently the meter can be graduated to read directly in thickness of film.

Rayon fabrics are sometimes chemically coated to make them fire-, mildew-, or water-resistant. If a radioisotope were compounded with the coating material it would be a simple matter to control uniformity and thickness of the coating by measuring intensity of radioactivity.

Radiocobalt and radio strontium have been used to collect electrostatic charge from textile materials and deliver the charge to measuring instruments. This has permitted measurements of the absolute amount of electricity generated during textile processing to be made for the first time. Attempts to do this by means other than radioactivity failed.

Some progress has been made toward the commercial use of these radioactive materials for dissipating unwanted charge around textile machinery. It appears unlikely that radiocobalt can be used for this purpose, but the application of radiostrontium seems more promising.

In closing, I would like to quote the great chemist Wohler who, when writing to Berzelius one hundred years ago on the status of organic chemistry, said

> *"Organic chemistry just now is enough to drive one mad. It gives me the impression of a primeval tropical forest, full of the most remarkable things, a monstrous and boundless thicket, with no way of escape, into which one may well dread to enter."*

That is an excellent description of the atomic energy field now, in 1953. In the meantime, however, what has happened to organic chemistry? Miracle drugs are practically tailor made; DDT and 2-4-D are taken for granted by the farmer. A hundred years from now what will be the status of atomic energy?

OPEN HOUSE . . .

(Continued from page 11)

devices. There will be a real flying saucer, the simplest motor in the world, man-made lightning, and a TV camera and receiver setup. You will have a chance to match your wits against an electrical brain, and try your luck on the kissometer.

Civil Engineering — Here you will be able to see the part the civil engineer plays in the construction of the many buildings, roads, and bridges

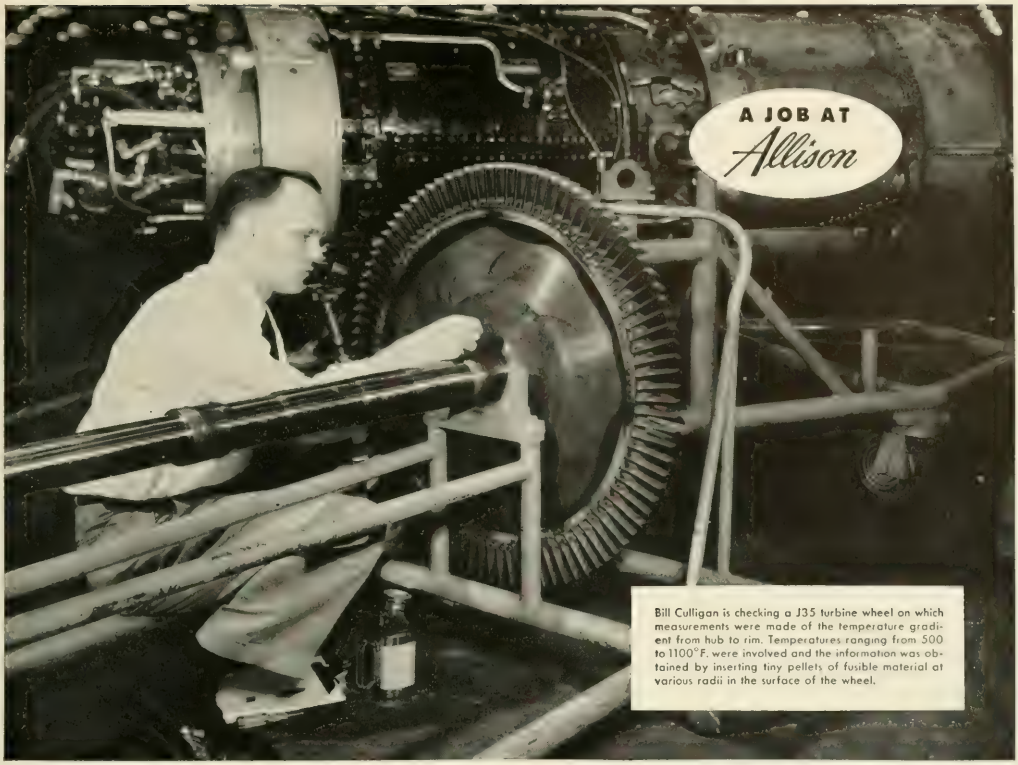
The testing machine at Talbot Lab breaking a concrete cylinder.

which we all use. There will be models and pictures of some of the famous feats of construction. The basic principles of surveying will be explained to you.

The Open House of 1953 will be a treat for everyone regardless of age. The displays will awe and please you. This will be a very enjoyable way to learn a little more about the great part that engineers play in our everyday life. There is no reason why everyone shouldn't be able to spend an enjoyable and educational day at the Enginnering Open House of 1953.

While attempting to accomplish a stickup, a criminal was caught in the act. Upon capturing him the arresting officer made the usual statement, "Anything you say may be held against you."

The prisoner's immediate reply was, "Jane Russell"!



Bill Culligan is checking a J35 turbine wheel on which measurements were made of the temperature gradient from hub to rim. Temperatures ranging from 500 to 1100°F. were involved and the information was obtained by inserting tiny pellets of fusible material at various radii in the surface of the wheel.

● William L. Culligan, Jr. received his B.S. and M.S. degrees in Aeronautical Engineering from the University of Michigan in 1945 and 1947. His first two years with Allison as a junior engineer were devoted to gaining direct experience in the operation of jet engines in the Experimental Test Department. In December, 1949, Bill was promoted to Experimental Engineer and has been specializing in applying improved instrumentation to jet engines as a means of obtaining better data for analyzing and predicting their performance. This has included some special "jet rakes" to obtain pressure and temperature data in the hot jet exhaust of engines on the test stand and in flight. There also were such things as quartz windows and periscopes to permit viewing the combustion inside the engine.

On one occasion he spent six weeks assisting in Air Force tests of an Allison engine at Eglin Field, Florida, where the inlet air temperature to the engine was varied from minus 65°F up to a "hot day" temperature of 110°F.

Today Bill is considered one of our experts on analyzing engine performance. He is only one of several hundred engineers who have interesting and important jobs in Allison's growing program of development and improvement for turbo-jet and turbo-prop aircraft engines. We think you, too, would like to work for the only manufacturer whose jet engines have accumulated more than 2,000,000 hours in the air.

Allison is looking for young men with degrees in

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A lesser number of openings exist for majors in Metallurgy, Electronics, Mathematics and Physics

For further information about YOUR engineering career at ALLISON, discuss it with your Placement Counselor and arrange for an early interview with the ALLISON representative the next time he visits your campus. Or, write now for further information: R. G. Greenwood, Engineering College Contact, Allison Division, General Motors Corporation, Indianapolis 6, Indiana.

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DRY LAB . . .

(Continued from page 36)

industrial organization and administration, and a supplement of cultural and humanistic studies. Options are also offered.

Mechanical Engineering. The courses in mechanical engineering "present the theory and practice of the generation, transmission, and utilization of power and of the theory of operation, design, testing, and construction of machines of all kinds." Third and fourth year courses are available in a variety of options including heat power, machine design, production, research, air conditioning and refrigeration, petroleum production and railway motive power.

Metallurgical Engineering. Chemical metallurgy deals with the chemical processes and the production and refining of metals. Mechanical metallurgy includes the processing, working and shaping of metals and alloys—rolling, forging, drawing, spinning and casting. Physical metallurgy concerns the nature, structure, physical and mechanical properties of metals and alloys, metallography, testing of metals and alloys, heat treatment of metals and alloys and their physical changes. The general curriculum of metallurgical engineering emphasizes physical metallurgy with specialized courses in ferrous and nonferrous metallography, physical metallurgy, ferrous and nonferrous process metallurgy, physics of metals, electrometallurgy, heat treatment, fuels and furnaces, alloy steels, and mechanical metallurgy.

Mining Engineering. Mining engineering provides instruction in the extraction of coal and minerals from the earth and their preparation for use. Specialized courses are offered in mine surveying, mine methods, prospecting, mine examination and ventilation, coal preparation, mineral dressing, mine administration, and design of mine plants.

Physics. Engineering physics offers training in fundamental physics and mathematics with junior and senior courses in physics, mathematics, and chemistry plus liberal allowance for specialization.

Sanitary Engineering. Closely resembling the civil engineering curriculum, sanitary engineering puts greater emphasis on the control of the environment to protect and improve health and comfort.

Theoretical and Applied Mechanics. The Department of T.A.M. offers courses in the mechanics of rigid and deformable bodies and of incompressible fluids with undergrad courses in statics and dynamics of rigid bodies, in strength of elastic and inelastic materials,and in hydraulics and fluid mechanics.

The entrance requirements to the College of Engineering have been increased as of September 1, 1953, and include four units of mathematics—two in algebra, one in plane geometry, and one-half each in solid and trigonometry. (One college unit is equal to two semesters of high school work.) Students lacking one unit of algebra will be admitted providing the deficiency is removed in their first year. This may delay graduation one semester unless the student attends a summer session immediately before or after his first year of college.

The College of Engineering campus is located on the northern part of the University campus (hence the title—North Campus). The buildings of each department in the college, their offices, classrooms and library are located here as are the many well equipped laboratories shared by the various departments.

And so, if you feel that you can qualify and that you are interested in serving society by serving science, join the ranks of that onehalf of one percent of our population that call themselves engineers. In short—come north, young man!

Joe: "What's the hurry."

Moe: "I bought a textbook and I'm trying to get to class before the next edition comes out."

—*The Auburn Engineer*

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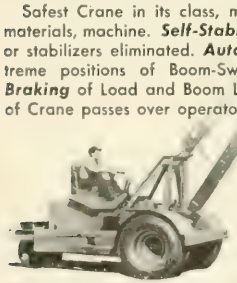

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The automobile industry has shown almost continual growth—far beyond the most optimistic expectations of the experts of not so many years ago.

And while the industry itself has shown this steady growth, Pontiac has grown even more spectacularly. Today Pontiac holds an enviable position. Its reputation for quality and value and its public acceptance are unsurpassed.

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PONTIAC

MOTOR DIVISION • PONTIAC, MICHIGAN

GENERAL MOTORS CORPORATION

AGRICULTURE . . .

(Continued from page 9)

choose the right type and size of engine for the tractor; he must design the tractor to give a pleasing appearance—always a good selling point, and he must design the tractor to be able to stand up in extremely wet, dusty, or cold conditions, or any other peculiar conditions the tractor might have to work under.

The tractor is only one of the hundreds of farm machines. Nearly all these machines must be designed, tested and perfected by engineers. The engineer also invents new machines and discovers methods of using machines for better economy of time and money. The engineer is indispensible to a mechanized farm.

The engineer's contribution to agriculture is not only in machines, however. His work extends much farther than that. His work is directly connected with the soil. He makes thousands of acres suitable for farming. To do this he may have to irrigate the land to provide water that is not in a suitable supply in nature, or he may have to drain land that has an excess of water. Soil and water conservation is one of the engineer's most important jobs in agriculture.

The engineer dams huge rivers to divert the flow of water and change deserts into fertile farm land through irrigation. Irrigation is no simple task—quite the contrary—it is a very great job. The dams must be placed at strategic places in the river in order to assure greatest success; the water may have to be piped for miles—another large assignment; and it must be easily accessible for irrigation of the fields. To be easily accessible, an intricate network of canals and pipes is needed to bring the water onto the fields in the proper amount at the proper time.

Diesel tractor equipped with a bulldozer is used for clearing land for stock grazing.

In some regions, however, water is present in such large amounts that this excess also presents quite a problem—another job for the engineer. If the land is level the excess water will lie on the surface to form ponds and marshes. In this case, the land must be drained. Usually this is done by laying a tile line underground. The tile line must be laid carefully in order to be effective, however. The proper drop of the line must be maintained, and the tile must be laid so that it will not become plugged. If tiling is not practical for drainage, drainage canals may be built. These also are a job for the engineer. Building a drainage canal is usually a job for a civil engineer. The canals must be carefully located in respect to the outlying land in order to be most effective. Often a tile network is hooked up to the drainage canal to drain large areas of land. The drainage combination is used quite extensively in the flat, fertile farm lands of the middle west.

On sloping land, run-off water washes away fertile soil. This is es-

(Continued on page 60)

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AGRICULTURE . . .

(Continued from page 56)

pecially true in areas that have lots of rainfall. The heavy rainfall, instead of soaking into the ground, flows down the slopes, carrying large amounts of

Diesel engine drives a centrifugal pump for the portable sprinklers irrigation of a total of 130 acres.

fertile topsoil with it. Washing can be, to a large extent, stopped by damming gullies, strip-cropping slopes, and farming along the contour of the slopes. Development of these ideas was also largely due to experimentation by engineers.

This article is only a brief summary of the engineer's work in agriculture. It would take several lengthy books to fully describe the work of the engineer in agriculture because he serves agriculture in thousands of ways. He develops machines to till the soil and plant and harvest crops. He also develops small time—and labor-saving machines and devices for the farmer—everything from milking machines to electric fences and devices for rolling and unrolling fence wire. He also develops methods for making the land more useful, such as crop irrigation, drainage canals and tilling, and dams to prevent washing of fertile soil. The United States owes a great deal to the agricultural progress which has been aided by the engineer. Engineering has a very definite and very important place in our nation's agriculture today.

Professor to noisy class: "Order, please."

Voice from rear of room: "Two beers."

—The Auburn Engineer

* * *

The early bird may get the worm, but did you ever stop to consider what the early worm gets?

DEPARTMENTS . . .

(Continued from page 22)

the nature and internal structure of metals and alloys, their chemical, physical, and mechanical properties, their heat treatment, and the methods of testing, commercial uses, defects, and design of new alloys for special purposes.

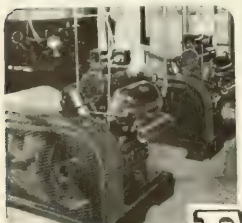
Mechanical metallurgy includes all the processes of working and shaping metals, such as rolling, forging, spinning, and casting. The mechanical properties of metals and alloys produced by the forming operations and with the proper design of equipment for accomplishing these tasks. In the foundry he is concerned with the effects of all variables of design of alloy composition, temperature of metal, molds and molding, and other techniques.

Mining engineering is concerned with the removal of useful materials from the earth's crust. It consists largely of the application of principles of geology and of civil, mechanical, electrical and chemical engineering to the discovery, exploration, development and extraction from the earth of economically valuable materials.

Several branches of mining offer opportunities to engineers. Coal mining has a profound effect on our national economy.

FRICK AIR CONDITIONING
Serves New Student Union

Two Frick "ECLIPSE" compressors handle 120 tons of air conditioning in this building at Kansas State Teachers College, Pittsburg, Kansas. Hundreds of students using the rooms are assured the health and comfort of cool, fresh air.



Frick "ECLIPSE" compressors handle low-temperature loads as well as air conditioning.

When air conditioning, refrigeration, ice making or quick-freezing problems arise, see your nearest Frick Branch or Distributor.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, offers a career in a growing industry.

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How to lick dust, moisture and acid fog

prevalent in the atmosphere surrounding the Rumford, Me., mill of the Oxford Paper Company posed a problem in power circuit maintenance. The combination of these elements caused wooden structures and even over-voltage insulators to become conducting, resulting in phase-to-phase flashovers and burndowns when ordinary overhead wires were used.

The solution of this serious problem was found by substituting Okolite-Okoprene Self-Supporting Aerial Cable for the open wires. According to company officials, the combination of Okolite high voltage moisture and heat resisting insulation, protected by non-conducting weather and chemical resistant Okoprene sheathing, has eliminated this trouble.

● ● ● ●

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE insulated wires and cables

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Is part of your future being built here?

Here you see the beginning of another addition to Alcoa's expanding facilities. This plant, at Rockdale, Texas, will be the first in the world to use power generated from lignite fuel and will produce 170 million pounds of aluminum a year. This and other new plants bring Alcoa's production capacity to a billion pounds of aluminum a year, four times as much as we produced in 1939. And still the demand for aluminum products continues to grow. Consider the opportunities for you if you choose to grow with us.

What can this mean as a career for you?

This is a production chart—shows the millions of pounds of aluminum produced by Alcoa each year between 1935 and 1951. Good men did good work to create this record. You can work with these same men, learn from them and qualify yourself for continually developing opportunities. And that production curve is still rising, we're still expanding, and opportunities for young men joining us now are almost limitless.

Ever-expanding Alcoa needs engineers, metallurgists, and technically minded "laymen" for production, research and sales positions. If you graduate soon, if you want to be with a dynamic company that's "going places," get in touch with us. Benefits are many; stability is a matter of proud record; *opportunities are unlimited.*

For more facts, consult your Placement Director.

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offers an unusual program of summer study and recreation . . . The

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provides excellent opportunities for study for undergraduate or graduate degrees, for satisfying prerequisites, for makeup, or refresher courses.

Graduate and undergraduate courses in the College of Engineering are offered in the fields of—

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ARCHITECTURE
ARCHITECTURAL ENGINEERING
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Classroom, laboratory, library and other teaching facilities are unexcelled in the Rocky Mountain region. Regular teaching staffs are supplemented by visiting lecturers from other institutions and industry. Special research projects and seminars offer opportunity for creative work.

All courses offered by the College of Engineering run for ten weeks—

JUNE 15 to AUGUST 25

Other University courses are offered for five-week or ten-week terms. (June 15-July 21; July 23-August 25.)

The University's own Recreation Department offers a planned program which supplements education. Students have ample opportunity to see scenic Colorado. Drives over spectacular mountain highways; weekend climbs to nearby peaks with experienced guides; easy hikes to adjacent mountain spots; steak fries and picnics, and campfire entertainment near mountain streams, are all part of the program.

Typical tuition and fees for the 10-week Engineering program are $100. The charge is determined by the number of hours carried.

Living accommodations are available in attractive and spacious University residence halls, private homes, fraternity and sorority houses, and student rooming houses. Typical room and board rates are $170 for 10-week term.

Choose the University of Colorado this summer. Combine makeup, refresher or graduate courses with a Colorado vacation.

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University of Colorado, Boulder, Colorado

Please send Engineering College information.

Your Name.....

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INTRODUCING . . .

(Continued from page 14)

neering Open House, as well as being the Treasurer of the Triangle Fraternity. He has been elected to two scholastic honoraries, Phi Eta Sigma, freshman honorary, and Sigma Tau.

Bob lives in Tuscola, Illinois, but last summer he spent quite a bit of his time at ROTC summer camp, at Fort Belvoir, Virginia, in the Engineering

BOB SCHRADER

Corps. The summer of '51 he spent working in a gold mine, ninety miles north of Fairbanks, Alaska. From this, one can see that Bob gets around, and he must really move fast, for he says he is unmarried, unpinned and fancy free.

Sports and reading are two of his pet hobbies. He likes to play basketball and occasionally tennis or golf. As for reading he comes under the heading of versatile and/or broad-minded, for he likes anything from science-fiction and on up to Shakespeare.

His future plans have all been laid out by our favorite Uncle. As far as he knows now he will go into the Army upon graduation. He says any plans of his own are at the present time nonexistent.

MELVIN RUDICH

The Publicity Chairman of the 1953 Engineering Open House, is kept quite busy with other activities, including a part-time job. He is Mel Rudich, a senior in general engineering, with a sales minor. Mel hails from Von Steuben High School in Chicago, where after graduation, he attended the Navy Pier branch of the University of Illinois for two years.

At present Mel is busy with Engineering Open House, is on the Publicity and Promotion Staff of the Technograph, acts as lab technician for the Physics Research Department, is Chairman of the Publicity Committee for the Hillel Foundation, and still finds enough time to represent North American Airlines, in handling campus ticket sales.

While at Navy Pier, Mel built the prize winning exhibit for the 1950 Open House. He constructed an electronic device for controlling electric train models by audio impulses. During his sophomore year, he headed the Social Dance Committee at the Pier. Also, while a soph, he became founder and first president of the first social fraternity at Navy Pier.

On the Champaign-Urbana campus, Mel was on both Mother's Day and Homecoming committees. He is finishing up two years with the Technograph.

MEL RUDICH

Mel is also a member of Pi Lambda Phi social fraternity.

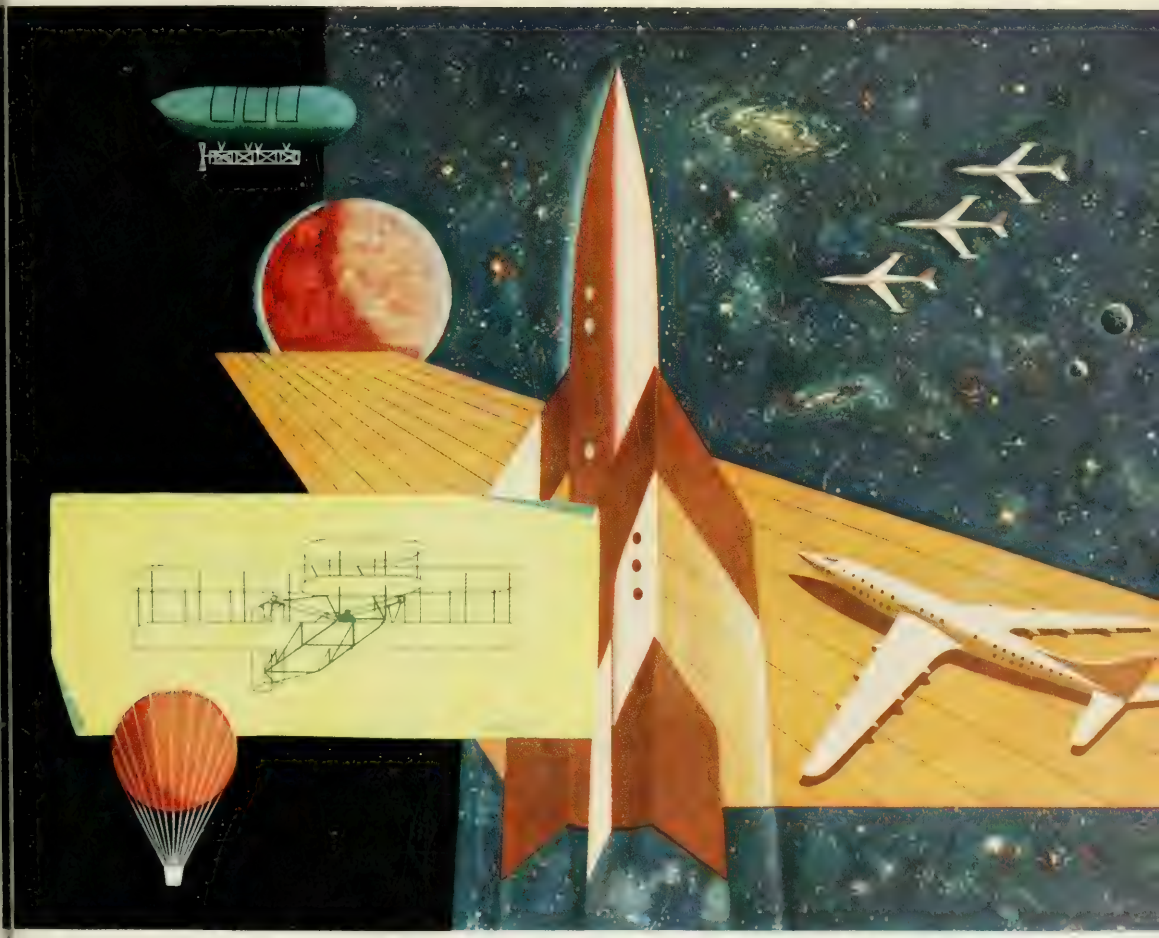
Mel's chief hobbies are photography and electronics, when he finds some spare time in which to relax.

When asked about his plans after graduation, Mel replied, "My future plans, I hope, will include doing graduate work in Commerce, so I can equip myself for a career in engineering sales, but my more immediate plans might involve a commission in the Air Force."

"You young fellers think you have to have a lot of money to gallivant around with the girls. Do you know what I was getting when I married your aunt?"

"No, Unkie; and we'll bet you didn't either!"

ILLINOIS
TECHNOGRAPH



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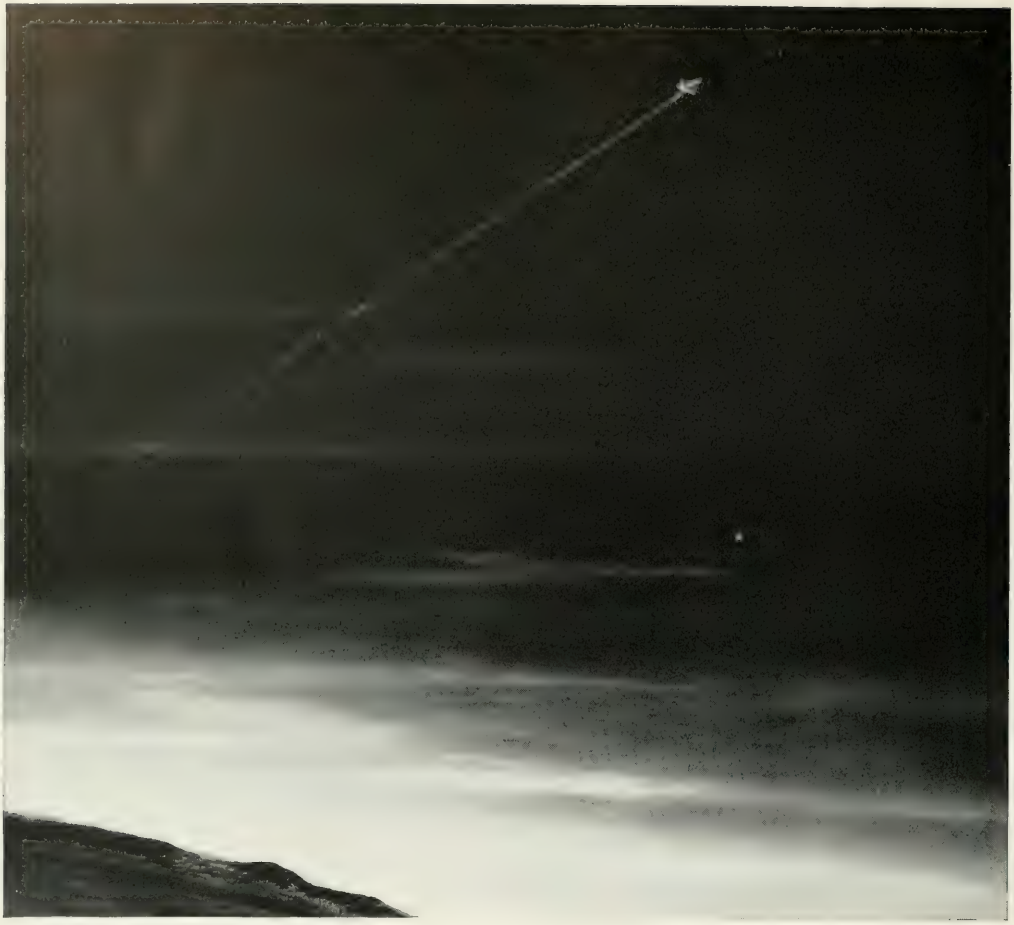

Tight reins in the stratosphere

FOR YEARS the performance of bombers and fighter planes at high altitudes has been seriously handicapped by "mushy" controls due to slackness in the cables.

That's because, when flying in the earth's upper atmosphere where it's sometimes as cold as minus 70°F., the aluminum airframe contracts much more than the carbon steel control cables. To take up the slack, all sorts of compensating devices were utilized. They were expensive. Were costly to maintain. They added cumbersome weight. Created potential lags in control response.

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our cover

The rise of aviation is illustrated in the drawing prepared for the National City Bank of New York who furnished the four color plates.

our frontispiece

The world's largest autotransformer furnishes power for the atomic energy plant now being constructed at Paducah, Kentucky. The transformer was built by the General Electric Company at it's Pittsfield, Massachusetts, plant for the Illinois Power Company. (Cut courtesy General Electric Company)

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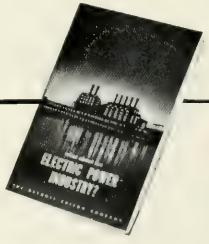
Don Blodgett set his sights on advancement following graduation from the University of Wisconsin with a BSEE. Five years of Army service delayed his start with Detroit Edison until 1946. Since then his career has been filled with challenge and responsibility. Today finds Don a Senior Engineer directing the work of our high-power laboratory, which proves new equipment design and construction before integration in our Electrical System. Career planning in Don's case still goes on for his engineering future is bright at Detroit Edison.



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a look into . . .

Education

by John V. Zinkus, E.E. '53

What is education? Have we ever given any thought to the many aspects of this subject—this goal which we have set for our selves and our children to attain? Many other people have thought about education. The Greeks and Romans realized the necessity of forming concrete ideas about it, and many of their philosophers wrote volumes on the subject. It is a problem to be settled but we can not expect to settle it here. We can, however, add our thoughts to the collection already amassed and allow each individual to try to be guided by these thoughts.

We have set forth a problem, a problem which has confounded the ages because of its greatness and necessity—a problem whose importance can not be overlooked if our civilization is to progress.

Fundamentally then, we must establish what an educated person really is. We have many authorities, but there is among their ideas a conflict of thought. In general, they seem to agree, yet each has his own point to make. There is a belief held by some that the educated person must be a scholar in the arts and the less that the physical sciences clutter up his mind the better off he is. It would seem that this idea is very short sighted, for humans must appreciate the beauty of nature and its functions to understand the most basic art of all. In the understanding of nature, it is necessary, at least, to have some fundamental knowledge of physics, which is only the interpretation of the laws of nature. In the natural things of life, the ideas of greatness prevail. It is those things created by nature which are the most beautiful, and it does not take a person who is a student of the arts to realize that this is so. The most beautiful things are very nearly always the simplest things.

Although the expression of the human thought in paintings in our modern age is art, or is so acclaimed by the art critics, I myself can seldom see the thought in the brilliant splashes of color that the modernistic student of art emphasizes. I do not here wish to condemn art, for it is important that it should be understood and appreciated; yet I do not believe that an appreciation of the so-called modern paintings of today constitutes art appreciation. The educated man should appreciate the arts, fine music, (this does not mean only the classical music), good literature, and beautiful scenery, whether it be on canvas or a spectacular view of mother nature in all her glory. It seems then that the educated person should appreciate the arts, but that this should only be a component part of his educational background.

It would seem also that the educated man should have a concept of physics. It is not necessary that he should know how to build an atom bomb, but he should be able to realize the potential greatness that the world and nature can offer. Physics is only a word picture of nature, and to scientists and engineers a mathematical picture of the nature that surrounds us. It is a necessity that the educated person be able to reason in logical steps and to realize the necessity of knowing about the functions of nature. It is, also necessary that the eductated person should be able to distinguish between right and wrong logic as connected with ideas, for it is necessary to prove the worth of ideas. In the book *The Aims of Education* by Alfred North Whitehead, Mr. Whitehead has this to say:

> "Now an idea is not worth much unless the propositions in which it is embodied are true. Accordingly an essential part of the proof of an idea is the proof, either by experiment or by logic, of the propositions. But it is not essential that this proof of the truth should constitute the first introduction to the idea. After all, its assertion by the authority of respectable teachers is sufficient evidence to begin with. In our first contact with a set of propositions, we commence by appreciating their importance. That is what we all do in after-life."[1]

It is important, however, that in obtaining the scientific knowledge, that the mind should be trained to use the logic and knowledge that educated person has at his command. It matters not that a man have knowledge if he does not use it in some manner, either for himself or for others.

The educated person should also have some idea of the history of man. The history that he should know about is not a succession of dates by themselves, but that which is more important, the knowledge of the events which have caused the world to progress as it has. History reveals to us all of the errors in judgment of civilizations past, and with this knowledge the educated person should be able to form convictions and attitudes toward his fellow human beings in his association with them. Just to have knowledge of these things does not do the educated man or society any good, it is the application of this knowledge that is the true test of a man's ability and education. A scholarly attitude with no interest in the function of society in which we live does not produce an educated mind. The educated mind is active and should differentiate between the right and wrong philosophies of life, morals, and government.

If the educated person is to guide human beings at all he should have a knowledge of biology also, for it is the very fundamental knowledge of life. Through knowledge of biology and physics the secrets of nature are revealed to man. Through biology the drives of man and other living organisms are known to man, and through this knowledge the educated person can do what is necessary to guide his less fortunate fellow beings.

The educated man has a certain debt to society, because by nature of his education his opinions are sought and followed. It is therefore a prime necessity that the educated person be as well informed in all affairs as he possibly can. If it is impossible that he can not know all that transpires, he should at least realize the necessity of education and its applications to social and moral life. With all of these factors considered, there is still one that the educated person should have. To be truly educated and to make use of this education, man should also have a philosophy of life. He must have some goal or ideal

[1] Alfred North Whitehead, *The Aims Of Education*, page 15.

which he is seeking to find or attain and he should continually work toward this end. The man who has an education but does not use it will tend to be inept in his ideas and policies in life and in the business world. The educated man should realize the value of his education and the value of education among the general public, for it is through the education of the people that progress in civilization occurs.

We must consider of course how a person may become educated. How does one gain this knowledge to be classified as an educated man? One method is to obtain the beginning and the training in educational institutions, such as colleges and preparatory schools. We can not just attend a college and expect to gain an education, it will require great effort on the part of the individual involved. Just riding through on the crest of things does not constitute an education, even though we have a degree to show that we have spent the required amount of time exposed to knowledge. Another method of attaining an education is by searching by ourselves for the truth and the beauty in nature, by developing a philosophy of life that suits our own needs, and then by using this knowledge that we have assembled to guide us in our life in society. We can assume then that to become educated we must have an inquiring mind and a desire to find out the truth.

In conclusion then we can say that the educated man should have the following requisites; he should have a certain appreciation of the arts, a general knowledge of the sciences, an understanding of biology and history, and a philosophy of life; but what is most important is that he should know how to coordinate and use his knowledge for the progress of civilization.

Editor's Note:

All seniors in electrical engineering are required to prepare a thesis for senior seminar. The subject of the thesis is left to the discretion of the student, most students choosing a subject of technical nature. However, the author of this paper chose a non-technical subject, and with the help of extensive references and expressed ideas of numerous university presidents throughout the nation he succeeded in producing an outstanding thesis on education. John Zinkus graduated with a degree in electrical engineering in February 1953 and is now employed by Collins Radio Corporation in Cedar Rapids, Iowa.

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It took a lot of engineering to make a better "grasshopper"

Engineers at Western Electric's St. Paul Shops are well pleased with their new-style "grasshopper" fuse—a small fuse used in Bell telephone central office equipment. The former model—in production for years—had been gradually refined 'til it seemed almost beyond further improvement. It was simple, inexpensive, efficient, came off the line fast. But . . .

It's an old Western Electric engineering custom to keep trying to make Bell telephone equipment still better, at still lower cost. The "grasshopper" was studied by a young engineer out of the University of Minnesota, Class of '40, who joined the Company in 1946. His studies indicated the most effective way to improve efficiency and cut costs further was to change the design.

Pursuing this lead the engineer and his group saw their opportunity to make an important contribution. They investigated the latest tooling techniques, new metals, finishing materials and methods, all of which are constantly under study by engineers at Western Electric plants. A simplified design, which permitted the use of the most modern tooling methods, resulted in a better fuse at lower cost that is saving thousands of dollars a year for Bell telephone companies.

There's an endless stream of such challenging assignments at Western Electric. Engineers of varied skills—mechanical, electrical, civil, chemical, metallurgical—find real satisfaction in working together on the important job of providing equipment for the best telephone service on earth.

How the grasshopper fuse works

Small fuses like this are used by the millions to protect certain telephone central office circuits against current overloads. Odd in appearance, the fuse is called the "grasshopper" because of its spring which is released when the fuse blows, displaying an indicator "flag" in open view and tripping an alarm so the trouble can be spotted and corrected at once.

NEW DESIGN

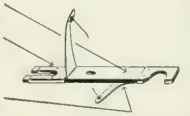
ONE-PIECE FORMED SPRING WITH INDICATING FLAG MADE BY STANDARD PUNCH PRESS METHODS.

FIBRE STRIP SPRAYED WITH COLORED LACQUER FOR CODE IDENTIFICATION.

INDICATOR SPRING HELD BY AND STAKED TO FLAT TERMINAL—SOLDERING ELIMINATED.

PRE-FORMED RADIAL BEND IS NOT VULNERABLE TO DEFORMATION BY IMPROPER HANDLING—NO ADJUSTMENT FOR TENSION NECESSARY.

ASSEMBLED FUSE



BLOWN FUSE

• *Engineer and punch press operator check production of parts for newly designed grasshopper fuse.*

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

TV at the Chicago Professional Colleges

by Warren H. Brandt, C.E. '54

Try to imagine the possibilities of a teaching medium that enabled 400 students to see a laboratory demonstration that formerly could accommodate a maximum number of twelve.

Of course, the teaching medium is television and it came into its own in dentistry at the University of Illinois College of Dentistry at Chicago on the afternoon of February 10, 1950. At a television presentation of "Theory and Practice of Periodontics" over 400 dentists attending the Midwinter Meeting of the Chicago Dental Society were spectators at professional demonstrations of various phases of dental and oral surgery techniques.

This use of the newest of the various communications media by the college of Dentistry was no accident or hastily conceived plan. On the contrary, ous communications media by the College's educational extension plans that have been in effect for some time. The forerunner of television as a teaching medium was the school's well-known Telephone Extension Program, a winter monthly feature sent out from the Dental College to 119 cities in the United States and Canada.

The dynamic force behind both the telephone and television programs is Dr. Saul Levy, assistant professor of Dentistry in the Department of Applied Materia Medica and Therapeutics. As Coordinator of the Postgraduate Extension Division, Dr. Levy was instrumental in setting up a suitable arrangement whereby unusual or advanced techniques in dentistry and oral surgery could be described and discussed by a panel of experts while the whole proceedings were broadcast to dentists throughout the country who had subscribed to the course.

The presentation of a program of the extent and scope of the Telephone Extension work involved an enormous amount of effort. At one time there were more than 250 cities in the network. The programs originate in Chicago at the Dental School campus. Moderators for the discussions during the programs include some of the most prominent dental surgeons from all parts of the country.

The present 1952-53 series of teaching over long distance telephone lines features *Current Advances in Dentistry*. This is the sixth year of this pioneering endeavor. On the first circuit back in 1947, were 20 dentists in Scranton, Pennsylvania. The following season 35 dentists in the Scranton area were enrolled together with a group of 25 dentists in New Iberia, Louisiana. In the fall of 1948, 150 dentists from 6 cities in Illinois were participants.

In October, 1949, the Telephone Extension Program was expanded on a national scale. At this time 5500 dentists in 143 cities from 42 states, the District of Columbia and Canada were registered for the course. For the 1950 program, 9000 dentists in 256 cities scattered over the United States and Canada heard the lectures and demonstrations.

The network to carry these programs throughout the country is provided by the American Telephone and Telegraph Company the same as it would do for commercial radio broadcasts. The difference is that the Dental College network requires a greater number of circuits than any commercial broadcast *ever* needed. The magnitude of the undertaking thus can be vividly compared to commercially sponsored programs that we hear every day on a national network.

At the transmitting end, the technical details of broadcasting are attended to by a staff of announcers and engineers from station WILL, the University's radio voice in Urbana. The use of WILL personnel at the studio imparts a professional broadcasting quality to the programs that has received considerable acclaim. The programs of course are not broadcast in the sense that the material goes out over radio waves, but are confined entirely to telephone lines from the transmitter to the thousands of receivers connected to special telephone circuits where ever an enrolled group is gathered. Thus, the telephone programs are really on a closed-circuit

basis insuring freedom from interruptions, mechanical interference, etc.

At the receiving end the dentists are gathered, often in some one's home, office or professional club, where the group has arranged for special amplification equipment to be set up by the local telephone company to insure that all members of the group can hear the presentations with equal clarity.

The telephone programs are offered during the fall and winter on the first Monday of each month. Each dentist who is a member of a group that has subscribed to the course receives an attractively printed manual to accompany the panel discussions. It is noteworthy to introduce at this point that the manual for the 1952-53 series of programs, which was printed and designed by the University of Illinois Press, received the award of exhibit in the American Institute of Graphic Arts "Printing for Commerce" show.

Many of the participating groups hold their own "round table" discussions following the broadcast. In this way the benefit of experience in some phase of the subject broadcast, by a member of a group is made available to all in that group. Comments by such a group as the Los Angeles Dental Society, California, give some indication of the success of the telephone venture, they said, "Monday's program was slightly terrific. Reception was excellent. Our dinner discussion was lively. This is the best yet." Such remarks from an assembly of dentists 3000 miles from the source of broadcast, amply prove the value of teaching via long distance telephone wires. Dr. Levy in noting this success says in his history of the Telephone Extension Program, "This particular teaching technic is looked upon with favor by the medical profession as indicated by the inauguration of similar programs by the Indiana State Medical Society in January, 1951, the Texas State Medical Society in February, 1952, and the Kentucky State Medical Society in 1952. We also have information that the American Medical Association is investigating the possibilities of a like program on a nation-wide basis in the near future.

Topics for presentation at the 1952-53 series of programs are Exodontia; Dental Materials and Therapeutic Aids in Everyday Dentistry; Removable Partial Dental Prosthesis; Treatment of Periodontal Diseases and Developmental Anomalies in Dental Practice. The last program was held March 9, 1953, and the moderator was Dr. Allan G. Brodie, Dean of the College of Dentistry of the University of Illinois.

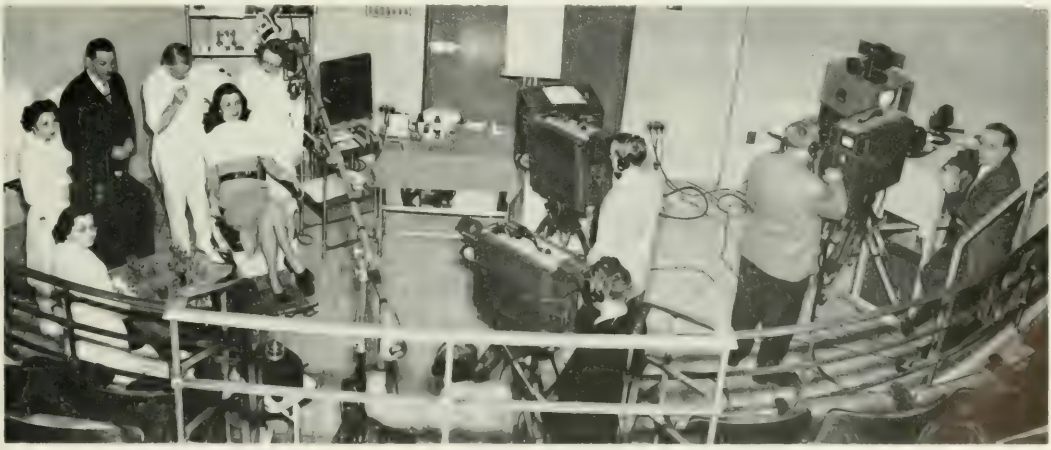
It was significant therefore, with this background of extension teaching that the role of television as a teaching medium would be examined.

When the Chicago Dental Society announced the dates for its 1950 Midwinter Meeting, Dr. Levy together with other members of the staff at the Dental School contacted TV station WBKB in Chicago to make arrangements for the station to furnish the necessary technical personnel, cameras and associated equipment to televise particularly important programs that were planned. Further agreements were effected with RCA Victor to provide the required number of television receivers and projection apparatus. All this equipment was rented from these companies by the University and technical personnel was provided by the station as mentioned.

The courses selected for televising were those that were of such a nature that did not lend themselves to demonstration before a large group. Among these were operations inside the mouth, structural theory relating to the placement of dental bridges, etc., with the use of the television camera, however, the groups arranged before the screens located throughout the Dental Building, were able to observe the innermost recesses of each patient's oral cavity and watch the dental operations and techniques used with ease.

Each day's demonstrations were followed with a round table discussion which was also televised thus reaching a larger audience than could possibly be accommodated in the most spacious hall on the Dental campus.

The highlight of the initial television presentation at the campus was the actual viewing through a microscope by the television camera of physiological specimens. It goes without saying that this technique alone would lend itself to a great number of applications throughout the sciences where ever a group is required to observe microscopic particles. The use of television in this connection with the resulting saving in time, ease of discussion by the lecturer and freedom from the distractions of having each member of the group peer through the microscope should be expanded and will be expanded as facilities become available. At the program in 1950, Dr.



Scene at the College of Dentistry television demonstration "Occlusion in Periodontal Practice." The gentleman at the left in the dark suit is Dr. Allan G. Brodie, Dean of the College of Dentistry. To his right is Dr. Balint Orban, Director of the Colorado Dental Foundation. Television technicians and equipment was furnished by station WBKD. (All photos courtesy of R. Lincoln Williston)

Balint Orban, director of the Colorado Dental Foundation, presented ten patients for operations. In addition to performing the actual operations before the television cameras, he showed the condition of tissues at various stages of intermediate healing through the microscope. This technique would almost be impossible if the 400 viewers had to gather around the microscope for a hasty glance. The possibilities here are unlimited.

The television demonstrations were repeated in 1951, to capacity audiences. It was about this time that plans were being made for the new Dental Buildings on the Chicago campus. As part of the wiring in the buildings the architects have provided co-axial cables between the lecture rooms to facilitate connections between TV cameras and receivers. This is in contrast to Dr. Levy's 1950 pioneering venture in television when he had the television station employees string their cables up and down the stairwells in the Dental College building. There is no reason to doubt that the co-axial cables in the new Dental Buildings will receive considerable use.

Aside from the ability of each member of the audience to see every demonstration and operation more clearly, the reduction in personnel necessary to assist in a demonstration is an important saving. Where one lecturer might give the same lecture several times, and his various assistants would be required to be present at each lecture; with TV the lecture need be given but once and a few aids are present to assist.

Dr. Saul Levy, of the University College of Dentistry, was instrumental in setting up its first educational television program.

Dr. Levy has many ideas to utilize TV on the undergraduate level as well as on the postgraduate level as has been done heretofore. As a pioneer in television at the University of Illinois, Dr. Levy can well expect that many of his unique innovations will be followed with interest by the new television station now being established in Urbana by the University.

In addition to the use of television on a closed-circuit system by the Dental College, the College of Medicine has cooperated with the Illinois State Medical Society in the presentation of a public service program over TV station WGN-TV (Channel 9) in Chicago. The series is entitled "How's Your Health?" and has featured prominent members of the Medical School faculty in discussions of various health topics.

The utilization of television as an educational medium is in its infancy. There are undoubtedly a great number of people who will dial out the common "blood and thunder" type of program in favor of an intelligently presented educational feature on the average listeners educational level, which is not as low as the cigarette ad men would like to make one believe it is. The colleges should take the lead in presenting programs of this type, their assured success will be an indication that the public still is interested in learning about themselves, their environments and their neighbor's environment whether he be in the next city or halfway around the world. The Chicago Professional Colleges have set a pace for the Urbana campus and it is hoped that the downstate television venture will have the same measure of success that has accompanied their monumental and pioneering effort.

The EE says:

If your sweetheart is a blond and you love a brunette, transformer.

If she gets grouchy, tickler.

If she wants to meet you for lunch, meter.

If she wants a fur coat, resistor.

If she continues to insist, eliminator.

She is easily induced by lines of force.

She is usually in a steady state.

She has no known imaginary components.

She has a continuous curve.

She has a negative temperature coefficient of resistance.

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Facts about Fafnir
Fafnir is the largest independent manufacturer of ball bearings in the country. From 1939 to 1950 its annual steel consumption increased almost 300%.
50,000 r.p.m. and not a tremor!
You can put your thumbnail against high speed machine tool shafts supported by Fafnir Super-Precision Ball Bearings and not feel vibration. Such smoothness of operation assures extremely accurate, fast work and prolonged life of parts.
The achievement of such results takes more than skill and care in the manufacture of ball bearings . . . it takes an "attitude and aptitude" for approaching bearing problems from the customer's viewpoint . . . gained from experience in not one or two but all industries. The Fafnir Bearing Company, New Britain, Conn.
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Best ECMA Article of the month . . .

TV for All

by Ed Bescherer, The Purdue Engineer

On September 4, 1951, forty million televiewers across the nation witnessed President Truman delivering an address to the Japanese Peace Treaty Conference in San Francisco. This was made possible by the magic of television and the new TD-2 Radio Relay System, which for the first time made a coast to coast TV broadcast possible. TD-2, a part of American Telephone and Telegraph's communication system, connects such important cities as New York, Chicago, Denver, San Francisco, and Los Angeles. A total of 52 cities have now been linked by this vast system.

Although TD-2 is often thought of in connection with the transmission of the television programs, it also has another important function. This is the carrying of many long distance phone calls. TD-2 is capable of carrying as many as six television channels or over a thousand telephone channels.

Basically TD-2 consists of a series of 107 relay stations spaced across the country. At each of these stations the television and telephone channels, which have been translated into super-high frequency microwaves, are received, amplified and then transmitted to the next station. In order to accomplish this task each station is equipped with four big antennae, two receiving and two transmitting, so that microwaves may be passed in both directions. Included at each station is the necessary equipment for handling and amplifying the microwave signals.

A Line-of-Sight Path

Selecting the sites and building the relay stations proved to be a very difficult job. Since microwaves travel in approximately straight lines, the stations had to be built on a line-of-sight path. Sites were chosen at rather short intervals (averaging distance 27.9 miles) and wherever possible on elevated locations so that a satisfactory line-of-sight path could be achieved with towers of structurally reasonable height.

Before the permanent relay towers were constructed it was necessary to run tests on the prospective sites. This was done with unique portable microwave towers, which could easily be raised to a height of 200 feet. The towers, consisting of numerous eight foot sections, were assembled completely from the ground. An erection frame placed at the bottom of the tower was used to lift the incomplete tower so that the eight foot sections could be added from he bottom. With the desired height reached, tests could be run to determine the acceptability of the sites.

Relay stations of several structural types were employed in the TD-2 system. Quite often in large cities the antennae were placed atop tall buildings with the rest of the equipment being stored inside. The remaining stations in the system fall into three general structural groups. Between New York and Des Moines, Iowa, the relay stations were built inside tall concrete towers with the antennae on top and the amplifying equipment in the tower. West of Des Moines the relay stations were housed in small buildings

The LaSalle, Michigan relay tower of the Detroit to Toledo system. (All photos courtesy Purdue Engineer)

with the antennae atop high steel towers. The high natural elevation of sites on the west coast permitted a few stations to consist of single story buildings with the antennae on the roof. The tallest tower in the system reaches a height of 200 ft.

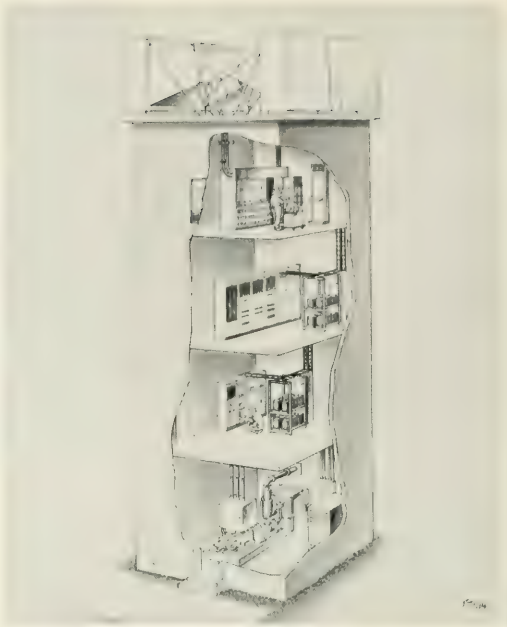
The delay lens antennae which plays such an important part in the system was especially developed for TD-2. The front of the antenna is a lens housing 10 ft square and 3 ft deep, which covers the delay lens. Behind the lens is a pyramid shaped horn, and feeding the horn is a wave guide which connects the antennae to the rest of the relay equipment in the lower levels of the tower. Microwaves being transmitted from a station come through the wave guide and horn until they reach the delay lens. The lens focuses them on the next station in much the same manner as light is focused by a search light.

Twelve Channels Minimize Interference

TD-2 operates over 12 channels; six in each direction. Each channel occupies a specific 20 mc band in the 3700 to 4200 mc common carrier band. The six channels in one direction use the same antenna and are spaced with the mid-band frequencies 80 mc apart. The six channels in the opposite direction, using the other antennae, are spaced equally between the first six channels so that actually there is a 40 mc separation between mid-band frequencies of adjacent opposite channels.

Each channel is assigned two frequencies 40 mc apart. The receiving and transmitting functions are alternated between these two frequencies at every station. By this means channels always leave a station on frequency 40 mc different from that upon which they entered, thus avoiding feedback around the antenna. This does not result in the loss of bands since a channel in the other direction is alternated on the same two frequencies. Since a channel is repeated on the same frequency at every other station, it was necessary to avoid placing the stations in a straight line in order to prevent overshooting. This was another factor to contend with when sites were being chosen for the stations.

This radio relay tower at Lake Zurch, Illinois, is for television network between Chicago and Milwaukee.



A cutaway view of a typical concrete station in the Transcontinental Radio Relay System. On the first floor is the diesel or gasoline engine for emergency power. The second and third floors house the main power supply. Amplifying and testing equipment occupies the top floor. The antennae are found on the roof.

Three functional types of relay stations are in operation along the TD-2 system. At the end points are the terminal type stations. Here the signals, either television programs or telephone circuits, enter and leave the system.

When a signal first enters a terminal station it is impressed on a 70 mc carrier in a unit known as the F. M. Terminal Transmitter. The 70 mc carrier is passed through a patching and monitoring bay where it is switched and monitored as desired. A radio transmitter then translates the signal to microwave frequencies and amplifies it. The microwaves are combined with the other channels and sent toward the next station.

Connecting the terminal stations are many auxiliary repeater stations. Here the microwaves, after being gathered by receiving the antennae, are separated into the various channels by a channel branching filter. Each channel is lowered to an intermediate frequency of 70 mc and sent to a radio receiver where it is amplified. A radio transmitter restores the channels to microwave frequencies 40 mc removed from the carrier on which they were received. The combined channels are then sent to the next station. Auxiliary repeater stations such as this are run completely unattended.

The third type of relay station in the system is the main relay station. Main relay stations were placed at points where it was desirable to be able to break into the system for adding or dropping of channels or for monitoring

operations. These stations are generally located in the larger cities along the route. In addition to the equipment found in an auxiliary station, main relay stations are provided with intermediate frequency patching bays for all switching and monitoring purposes.

When the early planning was being done on TD-2 it became obvious that a new type of electron tube would be necessary to meet the requirements of the system. Research by the Bell Telephone Laboratories led to the development of a new and very small tube known as the "close-spaced triode." This new tube has a space equal to about one-fifth of the diameter of a human hair between the grid and cathode. The grid wires are three ten-thousandths of an inch in diameter and are wound a thousandth of an inch apart. The "close-spaced triode" has extensive use in repeater and terminal equipment where it is used as an amplifier, modulator, oscillator and frequency multiplier.

Alarm System Prevents Breakdown

Due to the importance of maintaining uninterrupted telephone and television service it was necessary to incorporate into TD-2 a reliable alarm system. The alarm system developed for TD-2 greatly reduces the chance for a breakdown in the system. It operates through a series of alarm centers placed along the line. The system performs two functions: the first is reporting of detailed information to the alarm center of trouble at any unattended station, and the second is the sending of orders from the alarm to the affected station. An alarm center may be responsible for six unattended stations in each direction, a total of 12 stations.

A check on each station is maintained by the monitoring of a characteristic tone at the alarm center. Failure of the tone gives warning of malfunctioning at the station associated with that tone. In response to the warning an attendant at the alarm station sends out an order to the affected station, which by electrical means asks what is wrong. The alarm system is then able to report on any of 42 conditions which might be causing the trouble. After analyzing the trouble the attendant may send one or all of a maximum of ten orders to make the proper correction.

In addition to the alarm centers, maintenance centers were also installed in the system. These centers are responsible for the repair and periodic maintenance of the relay stations.

A TD-2 relay station operates on three power supplies: 12 v, 130 v, and 250 v. The power is drawn from batteries which are floated by a series of rectifiers operating from commercial 60 cycle power. An auxiliary power supply has been provided for times when the commercial power supply fails. On such occasions the batteries carry the load for about 8 min until an automatic gas engine or diesel engine alternator is warmed up and resumes the floating operation. In case of engine failure the batteries are capable of carrying the load for 8 hr, which would allow sufficient time for a repairman to reach the station.

A system of such a complicated nature as TD-2 was not developed overnight. The fact that this system exists is the result of years of work by the Bell System. Experimental work was started on a system of this nature by the Bell Telephone Laboratories at the end of the last war. The first experimental microwave relay system was set up between New York and Boston. This TD system was the forerunner of the TD-2 system.

As can be seen, the utilization of microwaves for use as a commercial communications system is a fairly new concept. In spite of this, the idea is spreading very rapidly. At this time plans are being made for enlarging the system. In the next few years the entire nation will be drawn close together by TD-2.

Horace Greeley's advice is still good . . .

"Go West, young man... go West"...

to Marquardt Aircraft Company, located in California's fabulous San Fernando Valley, where you will find your engineering future unlimited with the organization that is first and foremost in ramjet research, development, testing and production.

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NAME	DEGREE	YEAR
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ROBERT GOODYEAR	BS ME & EE	1933
ROBERT STIENECKER	BS AE	1940
R. P. LUCAS	BS AE	1952
AUGUST QUENON	BS E	1952
KENNETH E. WELCH	BS AE	1948

Inside Industry . . .

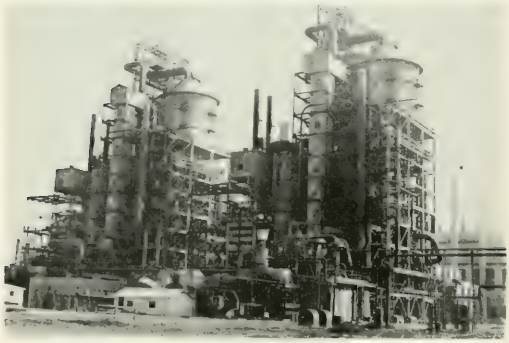
THE SHELL OIL COMPANY

Wood River Refinery

by Tom Tucker, Ch.E. '53

Forty-two gallons make one barrel, but 170,000 barrels are needed to make one day at the Shell Oil Company's Wood River, Illinois, refinery. But crude oil processing is only one phase of the operations at the refinery, for the main product development and application laboratory is located there.

The oil refinery is not a spectacular industry to the eye, as is the automobile industry, for the manufacturing



Wood River Refineries' twin "cat" crackers, each 15 stories tall. (All photos courtesy Shell Oil Company)

of finished petroleum products is an invisible process. The crude oil arrives by pipeline or tanker, is refined and reformed in steel equipment, and departs by pipeline, railroad, or truck without being seen. But, if the eye can not see the drama of oil, the mind can.

Only a century ago, petroleum was considered good only as a medicine. Today, petroleum is the source of 1,000 products. A century ago, oil was of concern only to the man who happened to be unlucky enough to have it on his property. It ruined his crops. It was almost impossible to sell. Today, oil is a fundamental concern of every government on this earth. The man with oil on his land can often forget about farming it. Oil! Rightly may it be called "black gold."

The drama of oil is in two acts. The first is entitled "production." The second is "research."

Although Illinois produces crude oil, that for the Shell refinery travels in 10-inch and 22-inch pipelines from fields as far away as West Texas, a distance of 900 miles. The crude is stored until needed in the refinery's 400-million-gallon "tank farm."

From the storage tanks, the sticky, viscous crude flows to the crude distillation units. Here it is heated and passed into fractionating columns. Crude oil is composed of many different hydrocarbons, each with a different boiling point. In the fractionating column, the low-boiling components are condensed in the cooler, upper section of the tower. The compounds with high boiling points collect in the lower section of the tower. From various points along the column, the primary ingredients of the oil are removed for further processing. From the top comes gasoline stock, then kerosene, a heavier gasoline stock, Diesel fuel stock, and others on down to the asphalt residue.

Formerly, this crude distillation was all the refining crude petroleum received. But petroleum, like a man with a sixth-grade education, could not take on the complex requirements of the world without more preparation. More powerful gasolines were needed. Special lubricating oils became necessities. More gasoline and less kerosene than simple distillation produced was demanded by the consumer.

The lubricating oil stock from the fractionation unit is first treated to remove asphalts. Then the stock is chilled to the point where the waxes solidify and can be filtered out. Resins, tars, and other sludge-forming materials are then removed by a special solvent. The oil is filtered through clay to remove undesirable color. Finally, the various lubri-

cating oil base stocks are blended together with special additives to make the various lubricants for which Shell is especially known.

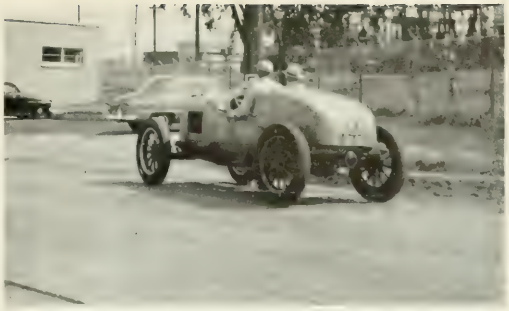
The manufacturing of motor gasolines is more involved than that of lubricants. While lube stock is taken from one part of the fractionating tower, gas stocks come from various parts. A portion of the high-boiling stock normally sent to the lube division is passed into the vacuum flasher. In this spherical unit, the remaining low-boiling compounds are separated from the asphalt-like base stock. Both the flashed distillate and the flasher bottoms are charged to the cracking units.

Two Types of Crackers Employed

Two types of crackers are in use at Wood River. The more common, and older, thermal cracker uses heat and high pressure to break the heavy hydrocarbon molecules into lighter ones. The Wood River thermal crackers are also used as additional crude units by feeding some crude along with the regular cracking stock. The catalytic, or "cat" cracker operates at lower pressures and temperatures, in addition to being more efficient than the thermal cracker. The units which Shell operates are the fluidized bed type. (The manner in which the solid catalyst is moved like a fluid was the subject of an article in an earlier issue of the *Illinois Technograph.*) Most refineries are not large enough to keep one such unit in operation. The twin "cats" at Wood River are not large enough for the rest of the refinery.

Some of the cracked stock goes directly to the light oil treaters to have objectionable odors removed before it is sold as motor gasoline. A heavier portion is sold without further treatment as fuel oil. Another product of cracking is coke. In the "cat" crackers, the coke collects on the catalyst and must be burned off. The heat produced is used in other sections of the refinery. The coke from the thermal crackers is sold to consumers of high quality carbon. The remaining products of the crackers are light hydrocarbons and undesirable isomers. These are fed to the gas plant to be separated and stabilized.

This gas plant separates the stock from the crackers plus stock direct from the crude units into stabilized gasoline (that from which the more volatile components have been removed), propane, butanes, butenes, and other special cuts. Again the gasoline is sent to sales after being de-odorized. The butenes and butanes plus the propane are fed to the polymerization and alkylation units. These units put the light molecules together to form gasoline components. Some of the propane is sold as bottled gas. Other products of the gas plant are isomerized, or reformed by subjecting them to high temperatures and pressures over a catalyst.



The winning car crossing the finish line in the mileage marathon.

The lightest cuts from the crude units and part of the straight run naphtha, which is also fed to the crackers, goes into specialties manufacturing. These varied products consist of aromatic compounds, special solvents, aviation gasoline base stock, motor gasoline, and jet fuel.

Process De-odorizes Products

As previously mentioned, the light oil treating plant removes the odors from gasoline. Kerosene and fuel oils from the crude distillation units are also de-odorized by the plant. The objectionable odors which must be removed are due to mercaptans present in all crude oil (normal butyl mercaptan is the defensive weapon of the skunk). These troublesome sulfur compounds are de-odorized by being changed into disulfides. This requires more sulfur than is in the oil. Since sulfur lowers the anti-knock quality of a gaso-

This 85-ton, 122-foot column for rectified absorber at gas plants being raised by a 150-ton temporary guy derrick. This operation is typical of several being performed in construction areas in the refinery.

fuel, more tetraethyllead must be used. Some refineries have installed units to recover elemental sulfur from these oils, but present process is not efficient enough to be installed at all refineries. Here research will find the answer. Perhaps the reader of this article will be the one who discovers the process. But in all probability, he will not be, because the

A 1932 Plymouth, which took third in the Class I competition, crossing the finish line.

The winner's car of the mileage marathon is given considerable interest by the crowd.

oil industry will have found the method before he has a a chance to finish his training. Such is the rate of progress in petroleum.

Shell is one of the leaders in petroleum research. At Wood River, the product development and application laboratory is responsible for improving the performance of internal combustion engines and other machines using petroleum products. One of the problems which has been studied in recent years is the fouling of aircraft sparkplugs. A fouled plug wastes fuel and causes high stresses in the engine. But the fouling is due to lead from the tetraethyllead used to produce high antiknock ratings. Shell research found an additive which did a more effective job of removing the lead than did the ethylene dibromide then used. The twin results of this research were fuel savings for the users of aircraft gasoline and added safety for air passengers.

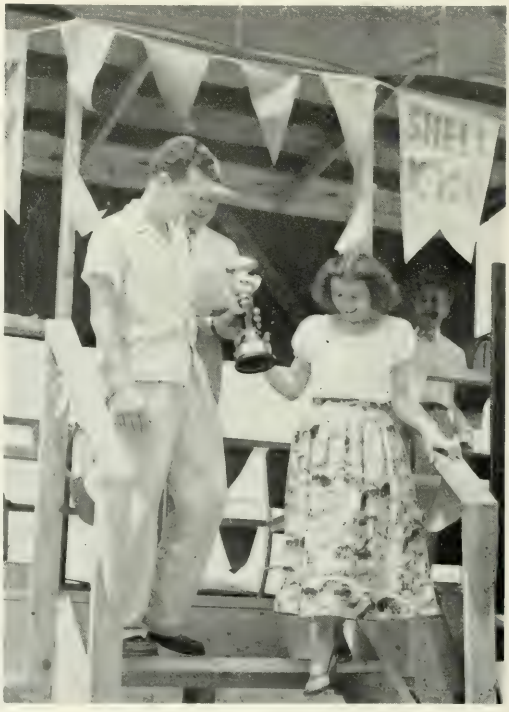
In another part of the Wood River research laboratory, there is a jet engine burner with a window in it. Through this window, Shell engineers can observe the process of combustion with various types of fuels. The ultimate goal is, of course, the best combination of burner design and fuel.

Perhaps the one bit of research at Wood River which receives the most publicity is the semi-official Shell Mileage Marathon. It started in 1939 as the result of the inevitable gas mileage comparisons between car owners. That year research director R. J. Greenshields won the Marathon, and thus the argument, by driving his 1933 Plymouth at the rate of 49.73 miles per gallon. Since that time, the chemists and engineers of the research laboratory have competed every year except during the war to see how high they could run their gas mileage.

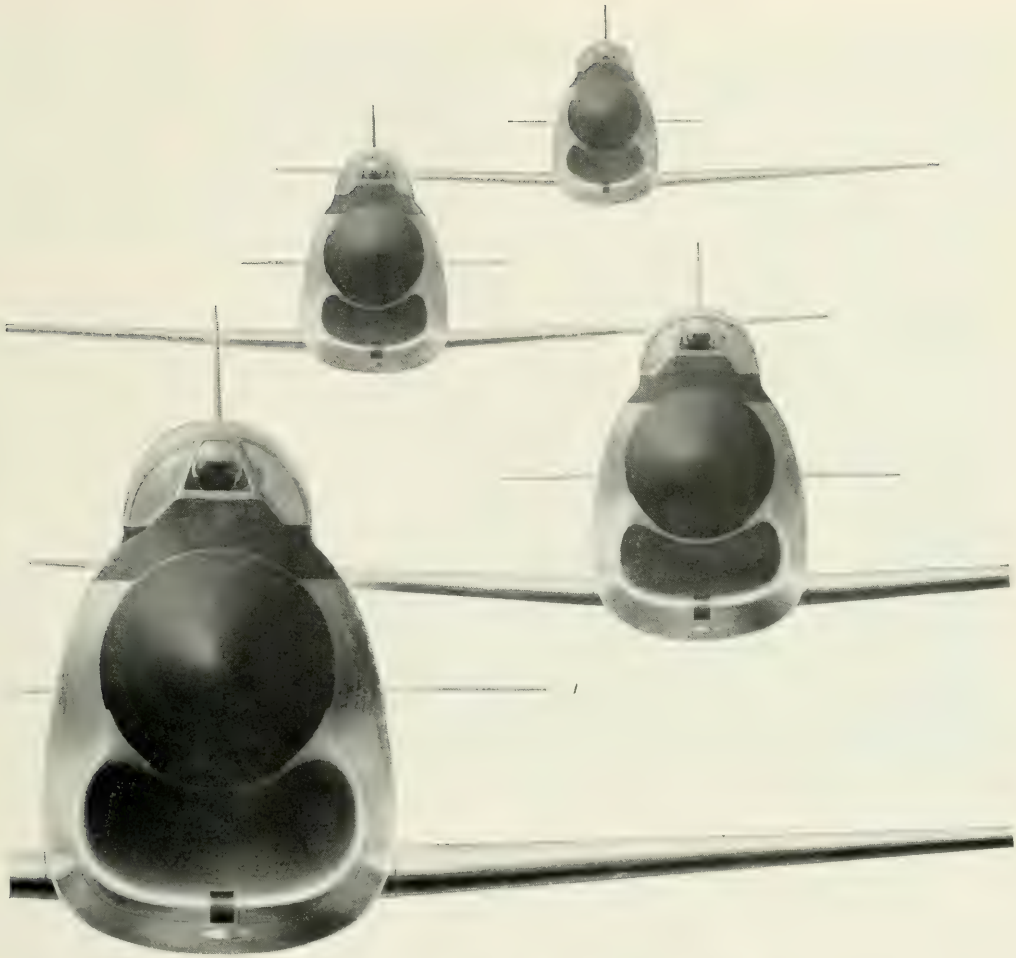
Although the average motorist would not care to drive under the conditions necessary to win the Mileage Marathon, much has been learned that can be of value to him. For example, in his 1947 Studebaker, Mr. Greenshields achieved 149.95 miles per gallon in the 1949 Mileage Marathon. But to do so, he had to make the following alterations: the compression ratio was upped from 6.5:1 to 10:1; the rear axle ratio was changed from 4.56:1 to 3.2:1; 7.00x16 tires were substituted for the standard 5.50x15 tires; the tire tread was buffed until only a narrow ridge touched the road and the tires then inflated to 110 *psi.;* and finally, all the engine accessories such as generator, water pump, and fan were disconnected. But the greatest portion of the increased mileage was due to the driving method. The car was accelerated in high gear to a speed of about 20 miles per hour. At this point, the engine was turned off and the car allowed to coast to a speed of 5 mph, when the engine was restarted and the cycle repeated.

Family Car Has Surprising Results

Because a few men in the research laboratory were working over cars to be used only in the Mileage Marathon, a second class of contestants was created. This class is for the ordinary family car. But even the family car can deliver some spectacular figures. In 1950, the winning 1947 Nash averaged over 79 miles per gallon. The winner of the 1952



Mr. and Mrs. V. M. Reedy, Class II winners, receive their trophy from G. C. Cunningham.



How would you like to make history?

The men who designed the F-86D *Sabre* Jets you see above made history. And so did the North American engineers who designed and developed the leading planes of World War II—the B-25 Mitchell and F-51 Mustang—and the other advanced planes in the *Sabre* Jet series. For 24 years North American engineers have been making history, because North American thinks in terms of the future. That's why North American always has career opportunities for young engineers who do fresh thinking, for young engineers with new ideas.

Today, North American engineers are making history in exciting new fields, including aircraft, guided missiles, jet engines, rocket development and research, electronics, atomic energy. Why not consider joining them when you complete your engineering training? In the meantime, feel free to write for any information you might want concerning a career in the aircraft industry.

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contest averaged over 169 miles per gallon in his reworked 1924 Chevrolet.

Perhaps the most important recent development to come from a Shell laboratory is the "Turbogrid" distillation tray. This product of Shell Development Company, subsidiary of the Shell Group and the research laboratory at Houston, Texas, promises to replace bubble-cap trays. The bubble-cap tray has a U-shaped cap suspended over an open pipe so that the vapors rising through the pipe must reverse direction twice to pass through the liquid on the tray. In contrast, the "Turbogrid" consists of a metal grating with slots of appropriate size. The tray can be built up from bar stock or it can be stamped out of sheet stock.

Besides the obvious advantage of a lower initial cost, the "Turbogrid" has a capacity of 50 to 100 per cent more than a bubble-cap tray of the same diameter. The construction of the tray gives increased turbulence, thus increasing the separation effected by each tray. The increased efficiency of the "Turbogrid" is also due to the absence of downcomers (pipes which remove the excess liquid from a tray by allowing it to flow down to the tray below), which allows utilization of the entire cross-section of the distillation column. The new trays can be made of corrosion-resistant alloys at far lower costs than would be possible for bubble-cap trays. And reversing the reaction of the bubble-cap tray, the new slotted tray increases in efficiency with increasing loads.

Personnel Turn-over is Low

The Shell family of employees is a happy one. Nearly three-fourths of the employees of the Wood River refinery have been with Shell for 10 or more years. The wages of the refinery worker are among the highest of all manufacturing industries. In addition to the usual vacation and insurance benefits, the Shell employee can purchase insurance which will pay up to 40 per cent of his regular wages when he is disabled. This insurance is in addition to disability benefits which Shell pays all its employees of one or more years.

After retirement, the Shell employee may have an income from three different sources. Shell pays a pension up to 40 percent of the employee's highest average earnings for five consecutive years during the last ten years that he is employed. When the employee receives Social Security payments, his Shell pension is reduced by the amount of the Social Security due to his earnings as a Shell employee. The third source of income is the Shell Provident Fund. Under this plan, the employee may contribute up to 10 per cent of his regular salary to a trust account which is paid upon his retirement. For every dollar the employee saves in this fund, the Company adds another.

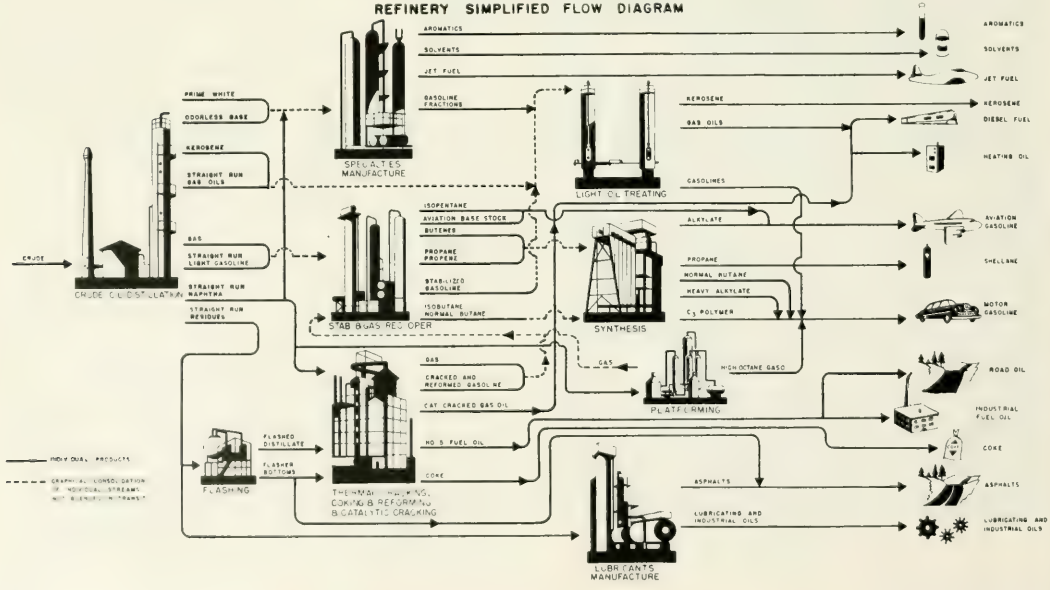
Health, Safety Program Successful

Promotion at Shell is based primarily on ability, but in the case of two equally qualified men, seniority is the deciding factor. A second factor in the Company promotion policy is constant supervision of all employees. No good job goes unnoticed and therefore unrewarded.

The health and safety of the Shell employee is well guarded at Wood River. Registered nurses are on duty in the emergency hospital 24 hours a day. During the day shift, the company doctor in charge of the hospital is available to all employees. The hospital staff also instructs all supervisory personnel in first aid. This instruction has been invaluable. Last summer, the life of one worker was saved when two of his supervisors applied artificial respiration after a heart attack. The record of less than three disabling injuries per million man-hours worked is less than half that of the whole refining industry.

The refinery sponsors many sports and social events. Some of the teams play only intra-plant games, but others compete with other industrial teams of the area. A tennis court, horseshoe pits, and softball diamonds are located on refinery property. The social functions include dances, picnics, and outings.

Chemical, civil, electrical, mechanical, metallurgical, mining, and petroleum production engineers can all find good jobs with a future at the Shell Oil Company.



INDIANA STIRRING SAND Corrosion Test, developed in Standard Oil laboratories, is operated by Technician John Becich. It measures the corrosion of bearings due to oxidation of motor oil.

Some men can't wait for time!

The familiar saying that "time waits for no man" has been given a reverse twist by Standard Oil scientists.

These chemists and engineers, impatient with time's measured pace, *don't wait for time.*

In our research laboratories at Whiting, for example, scientists discover the effects of months, even years, of elapsed time on petroleum products in a few hours. They artificially age certain products as much as 12 months in five hours. Some of these aging processes have originated in Standard Oil laboratories. Two such tests are the Indiana Stirring Sand Corrosion Test and the Indiana Stirring Oxidation Test. In two days these two processes determine the effect upon oil of months of normal driving.

Other artificial aging processes include the weatherometer, which manufactures rain, sunshine and heat to test the wearing quality of asphalt. The gasoline stability test uses heat, and oxygen under pressure, to determine how long gasoline can be stored without deteriorating.

This speeding up of time is characteristic of the restless curiosity that makes it possible to bring new and improved products to Standard Oil customers years sooner than might otherwise be possible.

Standard Oil Company
910 South Michigan Avenue
Chicago 80, Illinois

STANDARD

retiring . . .

Dean Harvey Jordan

by Hank Spies, Editorial Assistant, Engineering Experiment Station

Harvey H. Jordan was born in Waltham, Maine, on March 7, 1885. He received a Bachelor of Science degree in Civil Engineering from the University of Maine in 1910.

He has been with the University of Illinois since 1911. He was successively instructor, assistant, and associate professor of engineering drawing until 1921, and professor of engineering drawing and head of the department of General Engineering Drawing from 1922 until 1949. He was Assistant Dean of the College of Engineering from 1917 to 1934, and has served as Associate Dean since that time. He also served as acting dean of the College of Engineering from June, 1929, to October, 1930, during the illness of Dean Milo S. Ketchum.

The position of director of student placement of the College of Engineering has been capably filled by Dean Jordan for the last dozen years. Under his guidance, the placement program has grown to the extent that nearly four hundred companies conducted more than fifty-six hundred student interviews in the school year 1951-52.

The official history of the University of Illinois College of Engineering describes Associate Dean Jordan as "particularly efficient, being resourceful and energetic, orderly and systematic, tactful but prudent, firm but understanding and sympathetic in dealing with students."

He has played a prominent part in the development of "College Days" in high schools. He served as chairman of the University committee on "College Days" from 1939 to 1943.

Dean Jordan is co-author of two books, *Engineering Drawing* and *Descriptive Geometry*, and an Engineering Experiment Station bulletin on "The Pipe Orifice as a Means of Measuring the Flow of Water Through a Pipe."

Dean Jordan has been very active in his interests outside the University also. He was an alderman of the city of Urbana from 1921 to 1927. He was vice-president of the Society for the Promotion of Engineering Education, now the American Society for Engineering Education, in 1931 and '32, and was a member of the executive council from 1924 to 1927.

He is a member of the American Society of Civil Engineers, American Association for the Advancement of Science, Illinois Society of Professional Engineers, Phi Eta Sigma, Tau Beta Pi, Phi Kappa Phi, Sigma Tau, Chi Epsilon, Triangle Fraternity, Masons, University Club, and the Champaign-Urbana Kiwanis Club, which he served as president in 1936.

Each summer, he enthusiastically vacations in North Central Wisconsin, where he owns two cottages on Plum Lake.

Dean Jordan will be honored at a testimonial dinner scheduled for 7 p.m., May 15. Short talks are to be given by

DEAN HARVEY H. JORDAN

President George D. Stoddard, Dean William L. Everitt, Charles A. Davis of Moline, Chairman of the Engineering Alumni Committee , and Clyde L. Young, President of the Engineering Council. Professor Randolph P. Hoelscher, Dean Jordan's successor as head of the department of General Engineering Drawing (now the department of General Engineering), will be the master of ceremonies. Professor Hoelscher serves on a committee, headed by Assist-Dean Stanley H. Pierce, which is arranging the May 15 ceremony.

On behalf of the students, faculty, and alumni, a fund will be established to support the Dean Harvey H. Jordan Award. Personal gifts will also be presented to Dean and Mrs. Jordan.

The General Engineering and Mechanical Engineering departments are planning tributes, as are several firms with whom Dean Jordan has worked in his capacity as College of Engineering placement director.

Richard Rider

by Fred Kuhlemeier, E.E. '56

Richard Rider, supervisor of Television-Motion Pictures, has been here at Illinois since 1950. Originally from Council Bluffs, Iowa, he received his A.B. degree in English at the University of Nebrbaska in 1937. Since then he has gained an extensive amount of experience both in the field of education and the entertainment world.

After college, and up until 1940, Mr. Rider worked in New York as an actor, both on stage and on the radio. In 1940 his career was interrupted when he became an officer in the Army Air Corps, where, during the war, he flew a B-24 Liberator Bomber. After the war he continued his studies at Yale University and in 1947 he received his Master of Fine Arts degree from the Department of Drama. During the summer that followed Mr. Rider worked for Louis deRochemont, a Hollywood motion picture producer. In the fall he once more went back to school; this time as an instructor in the Fine Arts College at the University of Missouri.

During the remainder of 1948, after the school term was over, and the first part of 1949 he was employed by two television stations. The first, WBKB in Chicago, and the second, WLWC in Columbus, Ohio. While in Columbus Mr. Rider began studying for his Ph.D. at Ohio State University. Then in 1950, after completing two quarters at Ohio, he came here to Illinois to continue his studying.

His first job at the University (during 1951 and early 1952) was managing the National Association of Education Tape Network. This network makes educational tape recordings for more than seventy-five radio stations throughout the country. In July, 1952, he became supervisor of Television-Motion Pictures, Division of Communications. This department, which is located in the stadium, is well known because of its many collegiate functions which includes the making educational films for future television stations of this area, producing of films of all Illini football games, and the closed circuit televising of both Illini home basketball games and the state high basketball tournament. In the fall of 1953 this department, Mr. Rider says, will offer a new curriculum to students interested in television production.

When asked about his hobbies he replied that his spare time was well taken care of by his two daughters, ages five and three.

What's Happening at CRUCIBLE

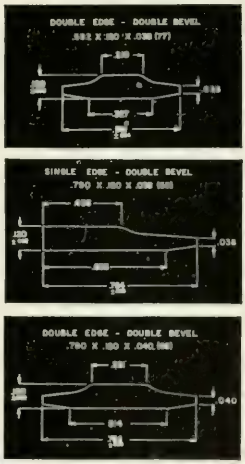
about clicker die steel

what it is

Clicker die steel is a special cold rolled alloy steel. It is used in making clicker dies for cutting leather, rubber, plastic, felt and fabrics of other compositions that go into the making of shoes and similar products.

Finished clicker die ready for cutting shoe leather.

Some of the clicker die steel standard shapes.



Wider shapes are used when dies are sized by surface grinding after forming and welding. Standard widths are provided when the dies are not to be surface ground.

how it is used

Clicker die steel is furnished to the die maker in either single or double edged form in one of several standard shapes. The die maker first shapes the die by bending the die steel to a pattern that provides the desired configuration, and then welds the two ends at a corner. He finishes the die by grinding a bevel on the outside of the cutting edge and filing the inside edge. Before the finished die is hardened and tempered, the die maker forms identification marks — combinations of circles and squares — in the cutting edge so that the material cut from it may be easily identified as to its size and style.

In the cutting operation, the leather or other material is placed on an oak block in the bed of the clicker machine. Then the die is placed by hand on the material which is cut as the aluminum faced head of the machine presses the die through it. The clicking sound which the head makes as it strikes the die is where the term "clicker machine" derived its name.

what it is composed of

Clicker die steel as produced by the Crucible Steel Company of America is a controlled electric steel in which the combination of carbon and alloy is designed for maximum toughness and proper hardness after heat treatment.

Experience has proved that cold finished clicker die steel is superior to hot rolled material for sizes approximately ¾ inch and narrower because of its lower degree of surface decarburization which permits the use of slightly thinner sections. Cold finished material also has a better surface finish with closer width and thickness tolerances and thinner edges that require less grinding and filing to complete the die.

CRUCIBLE'S engineering service

As with clicker die steel, the Crucible Steel Company of America is the leading producer of special purpose steels. If you have a problem in specialty steels, our staff of field metallurgists with over 50 years experience in fine steel making is available to help you solve it. Crucible Steel Company of America, General Sales and Operating Offices, Oliver Building, Pittsburgh, Pa.

CRUCIBLE first name in special purpose steels

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National Drawn Works, East Liverpool, Ohio • Sanderson-Halcomb Works, Syracuse, N. Y. • Trent Tube Company, East Troy, Wisconsin

WHAT *is* LIGHT?

by Tom Madden, Gen. E. '54

For centuries the world's prominent scientists have been searching for a solution to one of the greatest mysteries of our universe the composition of light. Although we make use of this phenomenon during nearly every waking hour, few of us realize the mystery contained in something as common as the glow of an electric light bulb. Specific theories regarding the nature of light are extremely numerous with new ones being presented periodically. Nearly all of these separate theories are, however, variations of one of four basic theories: the wave theory, the electromagnetic theory, the quantum theory, or the combined theory.

Before 1850 light was featured by most scientists as strictly a wave phenomenon. Many experiments have given conclusive evidence of the wave characteristics of light. Three of these experiments have been conducted as follows, using the waves of a body of water as an analogy:

1. When held before a light, a fine wire casts no shadow. This bending of light around a wire is comparable to the following of a water wave around a rock.

2. If a beam of light is passed through a very small hole, it casts a disk of light upon a screen. A careful examination of this disk shows that it is ribbed with dark and light concentric rings. This diffraction characteristic of light is similar to the action of waves as they enter a harbor through a narrow mouth and diverge.

3. Light passed through two pinholes very near each other produces parallel light and dark stripes upon a screen. This effect can be compared with the reinforcement and annulment of water waves as they meet.

These experiments demonstrate three characteristics of light which substantiate the wave theory.

In 1864 Maxwell predicted the existence of electrohagnetic waves. By using electrical data he calculated the velocity these waves should have, which turned out to be the same as the speed of light. Then in 1888 Hertz first produced these electromagnetic waves experimentally and found them to contain some of the same qualities that existed in light; the qualities of speed, reflection, refraction, refraction, and polarization. Continuing his theory, Maxwell predicted that light exerted a force on objects upon which it fell and proceeded to calculate that pressure. The actual experimenting on this prediction was done by Nichols and Hull in the United States and Lebedew in Russia. These scientists proved Maxwell's prediction correct.

Thus, to carry through Maxwell's theory on the composition of light, the vibrating electron within the atom is indicated as the probable source of light. The Zeeman effect (the resolution of spectral lines when the source of light is placed in a strong magnetic field) seems to prove this indication correct by showing that the vibrating source has a negative charge identical to the charge of an electron.

The early Greeks believed light to be composed of thousands of infinitesimally small particles which caused the sensation of light upon striking the eye. This theory was discarded long ago and not heard from again until about 1900 when Max Planck came forth with his quantum theory. At that time Planck was at work in search of an equation which would show that the amount of radiant energy from heated bodies was dependent upon wave length and temperature. He derived the following equation: E=energy, v=frequency of radiation, and h=Planck's constant. (This figure is a fundamental constant in nature.) This equation was satisfactory, however, only if the radiant energy was assumed to be emitted in separate bundles, called quanta, or corpuscles.

It was at this point that Einstein became interested in Planck's work and postulated that the quantum theory pertained to all forms of radiant energy, such as light, X-rays, and heat. Therefore, Einstein reasoned, the sensation of heat is the bombardment of the skin by quanta of heat. Similarly, the sensation of light is a bombardment of the optic nerves by light quanta, with color changes according to the Hd in Planck's equation.

The existence of the quantum theory helped clear up a problem presented by the "photo-electric" effect. The "photo-electric" effect is the ejection of electrons from a metal plate when held in a light. The velocity of these ejected electrons varies with color, but not intensity. Here Einstein said that the light quanta, which he called photons, knocked the electrons from the metal. Consequently, since the photons were supposed to be bundles of energy, the velocity of the ejected electrons should be dependent upon the energy of these photons.

The major weakness of the quantum theory is our complete lack of understanding as to the physical nature of a quantum. Since a complete quantum is necessary to produce the "photo-electric" effect, it would seem possible to measure the length of a quantum by cutting up, i.e. intermittently breaking with a shutter, a light beam until the "photo-electric" effect ceases. At this point the shutter would not be open long enough to permit a whole quantum to pass through, and by computation with the shutter time and the speed of light, the length of a quantum could be calculated. Although a mechanical shutter of such speed is impossible, a crystal immersed in a liquid has been successfully used. With such a device it has been determined that quanta are somewhat less than a few feet in length. Because of the enormous speed of light accurate measurement of a quantum's length is impossible.

At the present time the most widely acclaimed theory in scientific circles is that light consists of a combination of waves and corpuscles (quanta). The combination theory can best be expressed in the following way, again using water waves as an analogy: Light waves are waves of corpuscles. Just as a water wave crest may be described as a wave crest, a light wave crest may also be described as a crest merely because it contains more light molecules than a trough.

Recent speculation on the combined theory makes use of the fact that just as corpuscles of light show interference rings when directed upon crystals, electrons directed upon similar diffusing agents produce similar interference rings. Because of the similarity of these two phenomena scientists have been led to believe that an electron is a corpuscle and a wave. Hence, matter is waves and corpuscles.

From the past discussion we can readily see that many hours of research are yet to be spent before the scientific world arrives at a definite conclusion about the composition of light. Theories which now exist will undoubtedly give way to new ones, just as the past theories were dropped in favor of the present ones. However, until the final all-inclusive theory of light is formulated and proven, scientists will continue to make use of the present theories in their work with light.

What Is this Machine?

- ☐ *a vertical miller*
- ☐ *a grinding machine*
- ☐ *a broaching machine*
- ☐ *a contour shaper*

It is a grinding machine — specifically, the new Norton Propeller Blade Hub Grinder, used to grind the external surfaces of the hubs of aircraft propeller blades

A Typical Norton Development

This specialized Norton machine brings unusual efficiency to propeller grinding operations. As shown, the propeller blade is held *vertically* — by a workholding fixture on a work spindle with an anti-friction bearing — a new departure that avoids the errors normally caused by deflection when the blade is held *horizontally*, as in conventional methods.

The new Norton grinder has many other improved features adding up to greater speed, accuracy and simplicity of operation. And it requires considerably less floor space than do horizontal machines adapted for the same purpose.

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To Future Technicians

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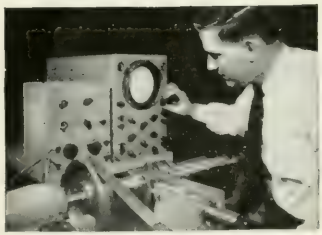
Free Booklet describes and illustrates representative types of Norton grinding and lapping machines. Write for your copy.



Guy D. Metcalf, B. S., E. E., Worcester Polytechnic Institute '49, checks smoothness of master cam spindle with specially designed electronic equipment — in connection with his work on Norton cam and contour grinders.

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TV at the U of I

by Maurice Garnholz, Aero. E. '56

Unobtrusively located down in the interior of the south-west corner of the stadium and built on an old basketball court are the well-laid beginnings of what may be the University of Illinois' top attractor of comments and attention for many months ahead.

This, as you have probably already deduced, is that part of the University known as the University of Illinois Television Studios. With the exception of a few things, nearly all of the equipment used by this organization is situated between the four walls of this rather large room. The control room is walled off into one corner, comprising the only truly partitioned section of the room. In there the master engineer sits in a chair and watches three different television screens—one view of each of the two cameras intermediate "shots" and one master screen, which shows to the control engineer the picture that is being sent over the air (or recorded). An office of a sort is merely a curtained off section of the room. The rest is left open for easy movement of cameras and equipment while telecasting or recording. A ceiling with sound-deadening insulation, a tile floor, a microphone boom, the control room, two television cameras, and lights of various intensities placed in diverse positions constitute the major working parts of the stadium studio. As yet the studio has no transmitter other than a tiny five-hundred milliwatt transmitter.

It is fairly well agreed among the studio personnel and especially by Dick Rider, head of the studio, that sufficient funds have been granted thus far for the studio, which is reasonably well equipped. It exists now as an integral part of the University budget, and is hence subject to state action along with other parts of the University.

The organization holding control of this place, namely, the University of Illinois Television Studios, officially came into existence in July, 1952. It was set up to carry out two principal functions, which were to "shoot" material for films and to be used in the activities, projects, and research that the University deems necessary to engage in. These films are being made and will be made with the idea in mind of using them on future television programs.

The television studios were organized under the able direction and supervision of Wilbur Schram; Dean of Division of Communications, and are presently also under the office of University Broadcasting, of which Robert B. Hudson, Associate Professor of Journalism and Communications, is director. He is responsible largely for consulting with the president on broadcasting matters at hand and on those with which he feels attention is necessary or with which conflict in the future is unavoidable.

Inspection of the microphone boom before a TV show. (Staff photos)

The purpose of the film making, now in process, is two-fold. The first phase, campus filming, takes in the normal functions and activities present on campus, such as the football games, Block I, Spring Carnival, Homecoming, Dad's Day, Mother's Day, etc. The remainder of the celluloids are being made for future use on television.

The long range project of the University as regards television spreads out into three specific areas. To bring to as wide a public as possible as much information and knowledge of the University, and of the knowledge it contains, through television is a very prominent purpose of this television project. To fulfill this purpose it will engage in the production of films to bring to the continuously expanding television audience of the state.

A second category into which the University of Illinois television is subdivided is that of entering into research as regards television and its methods, techniques, styles, etc. But it is necessary to differentiate between the electrical engineering division which does a different and extremely more technical type of research and the research spoken of here. Television research in connection with the studios is concerned with correcting mistakes in camera positions, acting, management, effect, trends, scrips, advertising, etc.

The third area into which the long range conception delves is that of television education. The University will soon offer vocational instruction to those interested in going into television asa career. I will go into this in more detail shortly.

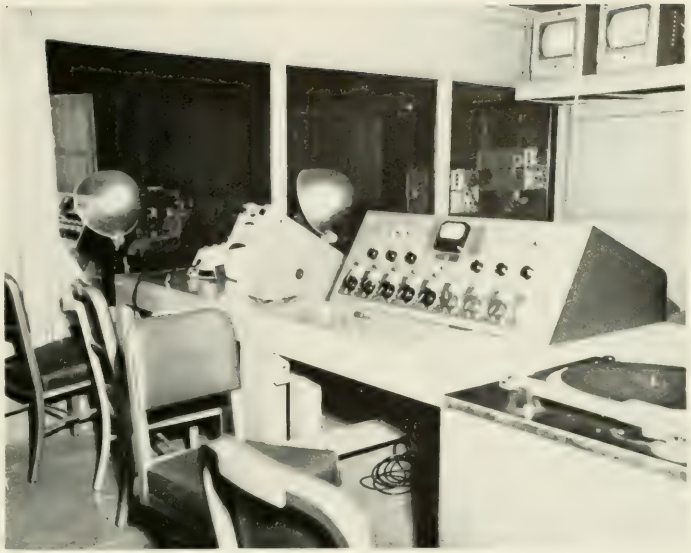
These aforementioned three areas, with possibly the exception of the first, will have been served whether or not the University operates a station in the future. This is evidently true, for research is being currently carried on, while vocational instruction will be given starting within the next few years, according to present plans.

The films for Channel 12 for use in the educational field in the Champaign-Urbana area will be authorized by the Board of Trustees of the University of Illinois. This University television station, Channel 12, will come into existence as a living entity if and when the previously mentioned Board files with the FCC (Federal Communications Commission) and if the two-year budget, particularly that dealing with the section on television, for 1953-1955 is passed in Springfield. Both are expected to be accomplished unless some unforeseen obstacle forces events to change greatly. Even if for some reason the channel is allowed to go by via de-

fault, the Board is still interested in exploring everything to the fullest possible extent now.

Whether the University will operate a station is not known for sure, but whether it does or not, the state will undoubtedly still be covered by a television network in the not too distant future. University television would afford a splendid opportunity to bring the trend of knowledge of the University of Illinois to a sizable portion of the public in the State of Illinois. There were 108 television stations a few months ago, while there will probably be over a thousand in the next few years. It would be an excellent phase of progress to bring the vast storehouse of knowledge and resources available here at the University to a large part of this state, and even to other regions of the country. The depth of this exploration would be profound indeed, and the effect on people, noticed particularly on children, would be very helpful in determining the best kinds of programs to be telecast for educational purposes. Instead of "Dragalong Deadeye" or "Suspenseful," programs of a more educational, but still interesting nature would be shown to the public. Such programs should have a definite effect of good educational value.

There is no direct instruction in television offered as yet this year, although there is a curriculum dealing in television programs now being offered. Also, the School of Journalism offers a program dealing in news and radio, which are very closely related subjects.



General View of the control room of a television station showing the control panel, monitors, and turntable.

The television training to be offered will be comparable to a trade school training, but with an elaborate background and a LAS education, which would tend to border more or less on the management side. This field of instruction also could be compared to an engineering curriculum.

At the present time the University television set up is largely occupied with taking educational films for television release. While the story matter of the movies is compiled in the field and on various parts of the campus, the beginnings, endings, narrations, and music, if any, are all filmed and recorded right at the stadium studio. Present in the films, which are usually either fifteen or thirty minutes long because of their designation for future TV programs, are numerous representations of the various colleges of the University. Among these are the opera workshop of the School of Music, two films on archeology from the Department of Sociology and Anthropology, and the College of Agriculture, of which Home Economics is a branch and a filmed subject. The Department of Entomology may make some films for television soon, the first one being on bees. Subjects of other films already completed have ranged through such varied subjects as music, dance, physical education, and the library.

In the College of Engineering, a film on engineering research—part of a series of films on research at the University of Illinois with such subjects as animal science and botany being present—concerning ceramics, materials testing, the railroad brake and wheel laboratory, and other phases of research in the engineering section of the campus has been made. Labeled as the chief problem by the television men in the shooting of films about engineering research is that of tying in the items filmed with those found in everyday life. Simple as

Public inspection of television equipment at the recent Festival of Contemporary Arts.

this may seem to young, aspiring engineers, it is often difficult for the layman and non-engineer to see the relationship between the two.

Another engineering project now ready to be put on film is designed to be shown in high schools throughout Illinois. Shot mostly on the engineering section of campus, it attempts to illustrate the opportunities to be found in the fields of engineering, both now and in the future.

Even *if* the television station is not approved by the State Legislature and consequently *not* built here at the University of Illinois, the films will by no means be wasted. It is hoped that they will be used for their original purposes or at the most, be only slightly warped replicas, and be used for the good of many on other television stations.

An organization, termed the National Distribution Center for television films, has been set up by other colleges for general educational purposes. This will tend to tie many colleges and universities together in a national cooperative venture. When one realizes the near impossibility of a station's originating, organizing, and televising its own programs, he can see that the NDC is a very good idea. Because of it, no one school will have to do as much work as it would have to do otherwise. Pooling the talents and top films of the country's educational institutions together will consequently help each university and college to have a better television station with a much better selection and quality of programs.

One of the features that has been attracting the most attention during the past few months is the televising of Illini basketball games. WGN radio station of Chicago does the actual televising of each game, while the University studio merely hooks up to WGN's transmitter and sends the picture obtained to the television theatre audience, which is also located in the stadium.

Football games and probably all other events of major interest and importance are planned telecasts of the future. As to how soon the University will have its own complete station and begin these TV broadcasts and educational programs is anybody's guess, but when it happens another rung on the ladder of progress will have been reached.

The most difficult part of getting to the top of the ladder is getting through the crowd at the bottom.

—Journeyman Barber

* * *

No man lives in vain who is important to the life of someone else.

If a man removes his hat in an elevator, he has one of two things — good manners or hair.

* * *

Life is a grindstone, and whether it grinds a man down or polishes him depends solely upon him.

* * *

The way to love anything is to realize it might be lost.

* * *

Falsehoods not only disagree with truths, but usually quarrel among themselves.

—Daniel Webster

* * *

There is nothing like self-support to bring on self-respect.

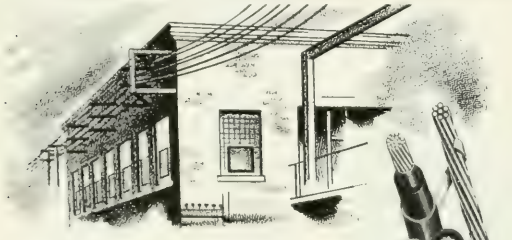
* * *

Sooner or later the man with a pull loses out to the man with a push.

* * *

Don't waste any time weeping because you are not a genius. John Orr Young, co-founder of that big advertising agency, Young & Rubicam, says, "The most competent people I have encountered have been fairly plain folk, given to an earnest pursuit of their special duties. I have observed more successes resulting from hard work than from spectacular genius."

—Nashua Cavalier



How to lick dust, moisture and acid fog

prevalent in the atmosphere surrounding the Rumford, Me., mill of the Oxford Paper Company posed a problem in power circuit maintenance. The combination of these elements caused wooden structures and even over-voltage insulators to become conducting, resulting in phase-to-phase flashovers and burndowns when ordinary overhead wires were used.

The solution of this serious problem was found by substituting Okolite-Okoprene Self-Supporting Aerial Cable for the open wires. According to company officials, the combination of Okolite high voltage moisture and heat resisting insulation, protected by non-conducting weather and chemical resistant Okoprene sheathing, has eliminated this trouble.

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Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

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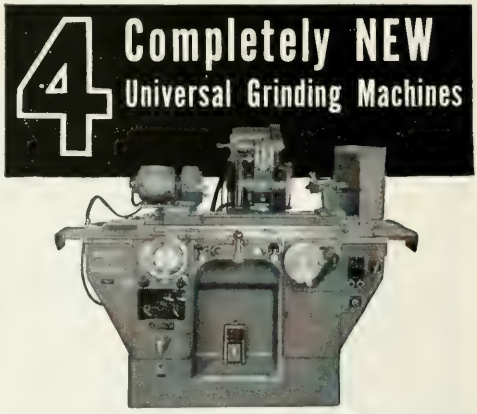

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Write for detailed Bulletins. Brown & Sharpe Mfg. Co., Providence 1, R.I., U.S.A.

Brown & Sharpe BS

Toledo's Water Pressure Rises and Falls with Popularity of TV Programs

(Reprinted from the Toledo Blade)

by Alan F. Schoedel, Staff Writer, Toledo Blade

Worker's Blood Pressure Shot Up Until Cause Was Found: Sure-Fire Formula Worked Out To Rate Shows

Radio has its Hooper Ratings, Hollywood has its box-office polls, but if the television industry wants to keep tabs on the popularity of its programs, let it consult the Toledo waterworks.

George J. Van Dorp, water commissioner, claims he can measure the appeal of a TV show by means of the fluctuations he has found in the water pressure during the evening. The pressure remains high during a television program, while everybody is sitting quietly watching, but suddenly drops at the end of a program because—guess what—so many persons get up and go to the bathroom at the same time.

Back in 1951, the water department began to be troubled seriously by sharp, sudden and unexplainable variations in the demand for water during an evening.

Consumption would fall off to an unusually low level for a while and then, in three or four minutes, it would zoom upward. Pressure in the mains would fall accordingly.

When this happened, the alarmed and puzzled crew at the Collins Park pumping station would throw another big pump into action. Minutes later the use of water would unaccountably drop below normal again, and the extra racing turbine would have to be turned off.

By summer of 1952, the trouble had become acute. It was costly in wear and tear on water department equipment, nerve-wracking for the pumping station crews.

Complaints of low pressure were received frequently from industrial plants. The flow of water to cool such machinery as metal presses or die-casting equipment, or for use in air-conditioning would suddenly go down to a comparative trickle.

Mr. Van Dorp assigned two investigators to find the source of the trouble. Were some big industrial plants, perhaps, using great quantities of water on an erratic schedule?

Armed with gauges, the troubleshooters tested pressure in mains throughout the city. The fluctuations were there, all right, but they seemed to be everywhere in the system. The cause just couldn't be localized.

Baffled, they went back to Mr. Van Dorp's office with their findings. Further check of the records showed one thing. The ups and downs occurred at intervals of a half-hour or hour.

Truth dawned on the water officials.

"We had found the culprit at last," Mr. Van Dorp related. "It was television."

What happened was that families all over Toledo would stay close to their television sets while a good program was on. When it ended and the between-program commercials came on, they would get drinks or give the last of the dinner dishes a hasty scrubbing before the next show. But the largest use unquestionably, Mr. Van Dorp says, is that of bathroom facilities which use an average of eight gallons for each operation.

For example, at the start of "I Love Lucy" — top program on TV by the Van Dorp rating system—one night recently, the rate of water consumption went down 13.8 per cent from the normal pumpage line. In the space of about five minutes when the program ended, it shot up 22 per cent over the low, showing a brief net gain in use of 8.2 per cent.

On another night, pressure in the water mains in Point Place—hardest hit by these fluctuations—dropped 30 per cent in a matter of minutes because so much water was being used.

"In the past, when a pressure drop like that occurred, we would send out an emergency crew to see if a 12-inch main, or even a larger one, had burst," said Mr. Van Dorp.

At the Collins park pumping station, a needle moving over a slowly rotating disc traces throughout the day the rate, in millions of gallons, at which water is being pumped to keep the mains full. It shows with fascinating accuracy the public reaction to a program, right down to the commercials.

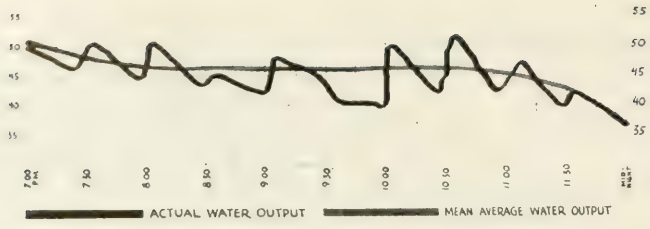
For example, on a recent TV "fight night" the gallonage dropped off at 10 p.m. when the boxing bout began, but spurted upward when the fight ended, well before 11 p.m., instead of on the hour.

Water consumption was generally low during the hour-long drama telecast on Sunday night, Jan. 18, between 1 and 10.

But about 9:20 it rose 6.5 per cent for just a couple of minutes. About 9:40 there was a similar brief upward swing of 10.5 per cent.

"Those are the commercials," Mr. Van Dorp explained. "People left their sets while the commercials were on and used water in various ways."

The same sort of evidence convinced



GRAPH SHOWS HOW WATER USE FLUCTUATES IN TYPICAL EVENING

Good show from 9:30 to 10, wasn't it? Figures at left and right indicate pumpage rate in terms of millions of gallons per day

the water commissioner that Ed Sullivan's show, "Toast of the Town," is a "slow starter" because of the rather lengthy commercial at the beginning.

Water use drops off slowly at the start of this program, and Mr. Van Dorp attributes this to the fact that people know there is going to be a long introductory announcement and advertising talk, just as they know that if they miss the first act of such a variety show it won't affect the continuity for them. By contrast, a show like "I Love Lucy" demands—and gets immediate attention right from the start.

The men at the pumping station get a laugh out of those pressure changes now," Mr. Van Dorp said.

"They know what shows are coming up on TV, and they can tell in advance what's going to happen. They know the abnormal demand will last only a few minutes, so they don't turn on one of the extra pumps.

"We still get some complaints about pressure, of course, but there's nothing we can do we just tell the people what the reason is. We used to be worried over whether we were negligent in some way that we couldn't understand."

Using the data available from the department charts, Mr. Van Dorp worked out his rating of TV shows.

Like the true pollster, concerned with medians and weighted averages and variable factors, Mr. Van Dorp has devised a formula which can be applied by waterworks engineers in other cities with the same problem to give ratings to TV programs affecting pressure. His formula checks "Program Popularity through Pumpage and Pressure," which Mr. Van Dorp has shortened to "P Rating."

He recognizes that in Toledo the formula is simplified because there is only one television station here. He also makes allowance for the fact that the proportion of water going to private homes rather than industry varies in different cities—and that's important to the rating.

Supporting Mr. Van Dorp's theory is the experience of the Detroit superintendent of water, L. G. Lenhart. He said that any popular show or special event that would attract attention to television or radio caused a "terrific bump" in the pumping rate.

His department, he said, had drawn up its own charts showing relative popularity of events and shows.

That this is the first time the theory has been expressed publicly was confirmed by W. A. Hardenbergh, one of the editors of *Public Works Magazine* in New York. He had first heard of the explanation, he said, from Mr. Van Dorp at a meeting of waterworks technicians in Cleveland. A paper of Mr. Van Dorp's was published on the water use fluctuation in the magazine's March issue, he said.

Just one thing, Mr. Taxpayer, Mr. Van Dorp wants it known that he worked out the formula on his own time.

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Pilotless Bombers Made With FRICK

Air Conditioning

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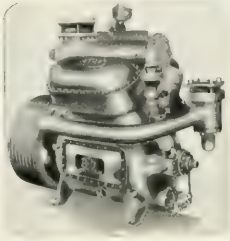

Frick "ECLIPSE" Compressors Handle Air Conditioning Work with Extra Economy: ask for details.

For dependability and convenience, specify Frick air conditioning, refrigerating, ice making and quick freezing equipment.

For a position with a future inquire about the Frick Graduate Training Course in Refrigeration and Air Conditioning. Operated over 30 years, it offers a career in a growing industry.

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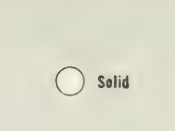
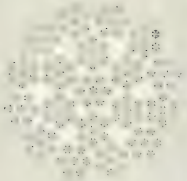


Solid

7 strand Concentric Stranding

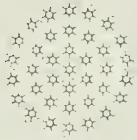
19 strand Concentric Stranding

37 strand Concentric Stranding



19 x 7 x 19 Rope-Lay Bunched

7 x 19 x 7 Rope-Lay Bunched



37 x 7 Rope-Lay Concentric

19 x 7 Rope-Lay Concentric

7 x 7 Rope-Lay Concentric

No. 2 in a series

The Importance of Electrical Conductors

In the ability to transmit electricity, all forms of matter may be divided into two general classes, namely, conductors and insulators. Conductors permit electric current to flow readily; that is, they offer little resistance to its flow, whereas, insulators offer relatively great resistance to the flow of electricity. All substances at normal temperatures offer some resistance to the flow of electric current. In general, the metals are good conductors, while glass, oil and most organic substances are classed as insulators. Although silver offers the lowest resistance to the flow of electricity of the common metals, its cost is such that it is not widely used as a conductor. The conductors most generally used in the cable industry are made of copper or aluminum.

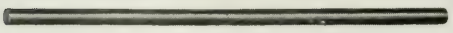
The manner in which electricity flows through elementary material may be readily visualized from the modern concepts of the structure of matter. According to these concepts all elements are made up of minute indivisible particles called atoms. These in turn are composed of a positively charged nucleus around which one or more very small negatively charged particles, called electrons, rotate at high velocity. In conductors, some of these electrons are free to move when only a small difference of potential is applied to the ends of the conductor and, since they are negatively charged, they flow to the positively charged end. This movement of electrons is electric current.

In passing through conductors, *the electrons must pass through the electron fields of many atoms. They thus collide with the atomic nuclei and other electrons. These collisions obstruct the flow of electrons and result in electrical resistance.*

The resistance of a homogeneous conductor of uniform cross-sectional area varies directly as its length and inversely as its cross-section, the length being in the direction of current flow. That is, $R = \rho L/A$ where, R is the resistance in ohms, L is the length in the direction of current flow, A is the area perpendicular to the length and ρ is a constant of the particular material known as its specific resistivity. When the length and area are expressed in the same units such as L = one inch and A = one square inch, $R = \rho \times 1/1$ or $R = \rho$, the specific resistance of the material in ohms per inch cube.

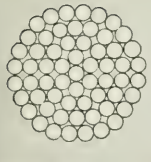
The length and area of a conductor are generally expressed in other units than inches. The most commonly used unit of cross-sectional area used in the cable industry is the circular mil, usually designated as cir. mil or CM. This

UNITED STATES RUBBER COMPANY

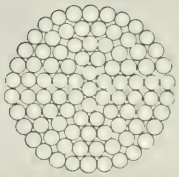


Solid

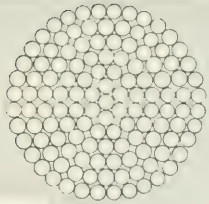
Concentric Stranding



61 strand Concentric Stranding



91 strand Concentric Stranding



127 strand Concentric Stranding

he area of a circle whose diameter is e mil, 0.001 inch. The area of a cir- ar mil is $\pi/4$ or 0.7854 of a square . The unit of length usually associ- d with this unit is the foot and the istance becomes ohms per CM-foot. e resistance of annealed copper and minum per circular mil-foot at 20C 10.371 and 17.011 ohms respec- ly. The resistance of a copper con- ctor 64 mils in diameter and one foot g thus becomes $10.371 \div 64^2$ or 0253 ohms.

sizes of electrical conductors *are ex- ssed in the United States in terms of American Wire Gauge. This was ginally set up on the basis of a geo- trical progression of 39 steps or sizes ween a wire 460 mils in diameter ze 4/0) and a wire 5 mils in diameter ze 36). The ratio of the diameter of ire to that of the next larger size in series is 39 $\sqrt{460/5}=1.12293$. This o has since been used to extend the erican Wire Gauge (AWG) to sizes aller than 36 AWG (5 mils). The es of conductors larger than 4/0 are ressed in circular mil area. The size a conductor made up of a number of es is determined from the sum of circular mil areas of the individual es.*

When current flows through a con- ctor there is, according to Ohm's law, oltage drop of $E = IR$, where E is in ts, I is in amperes and R is in ohms ng the conductor and power equal to watts is converted to heat. Since IR, this power converted to heat be- nes I^2R watts. These two factors, tage drop and conductor heating, are prime importance in the design of conductors. Conductors must be sufficiently large in cross-sectional area, that is, must have sufficient low resistance that the voltage drop does not become excessive. In good design this voltage drop should not exceed 3 per cent for power circuits or 1 per cent for lighting circuits. The conductors should also be large enough that their temperature does not exceed that for which their insulation is designed. This is referred to as the current carrying capacity of conductors. The current carrying capacities of the various sizes of conductors, conductor insulations and installation conditions have been established. It should be noted that the temperature attained by a conductor depends not only on the amount of heat generated but also on the thermal resistance of its surroundings.

In addition to providing satisfactory voltage drop and current carrying capacity, conductors must be designed to provide adequate flexibility during installation and service. This is accomplished by building up the conductor from one or more adequately small wires depending on the flexibility required. For example, the conductor for heater cord or welding cable which is subject to repeated flexing in service is usually made up of copper strands having a diameter of .005" or .0063" while the conductor for overhead weatherproof cable may be a single wire.

For reprints of these pages write to address below.

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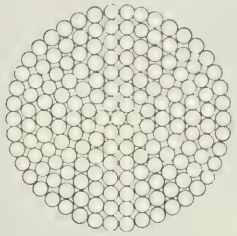
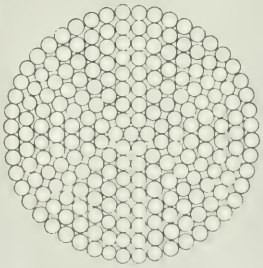
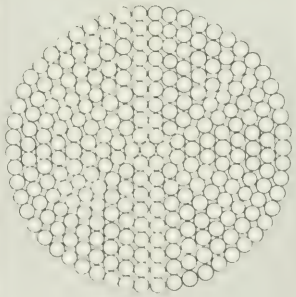


169 strand Concentric Stranding

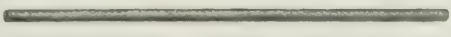


217 strand Concentric Stranding



271 strand Concentric Stranding

Rope Stranding



Bunched Stranding

The Honorable Herbert Hoover was invited by ECMA Chairman Paustian to write a message to student engineers for simultaneous publication in all member magazines of ECMA. Mr. Hoover offered the following:

simultaneous ECMA article . . .

The Engineers Can Help Save Our National Life

by the Honorable Herbert Hoover

(Reprint of an Address delivered to the Northwest Engineering Centennial)

This is not a political treatise. My first text comes from the agreement of both political platforms that the nation is mired down in a swamp of spending, inflation, and taxes. Both parties disagree on who-done-it. They seem to agree upon the obvious that reduction of Federal expenditures would be a good step to get out of the swamp but there is wide disagreement on where to begin and how much.

However, I am suggesting something else which is a partial method of relief, and that is where the engineers come in. That partial remedy for our ills is with all our might to stimulate scientific discovery, invention and their application by our engineers. That would increase productivity per capita and thereby mitigate these burdens. I do not guarantee it can work fast enough to save the American way of life but it could help.

The basis of this hope lies in our experience from three great hot wars. By increased productivity after these wars the credit of our nation was restored and the prosperity of our people moved into high levels. That was true after the War of the Revolution, the Civil War, and the First World War. But this extension of the Second World War into six years of cold war is where my belief comes from, that this is now only a partial remedy. Otherwise a continuation of these spending, taxing and inflation policies can have but one result. That is a national socialistic state.

After the War of the Revolution free initiative in expansion of our agriculture and the application of steam power in the factories increased our productivity, restored our national credit and gave a great lift to the standard of living.

After the Civil War the expansion of the railways brought millions of new fertile acres into productivity. With this, and with growing skills in free industry the nation again recovered and marched forward.

After World War I, scientific discoveries and inventions, and still more growth of skills and improved processes found expression in the expansion of motor transport and electrification, radio and airplanes. And from cheaper costs of production we remedied the ravages of war and rose to the highest average standard of living in all human history.

Since the Second World War we have again made great advances in science and invention. We have built many improved plants but we have not yet been able to catch up with the spenders and the tax-collectors.

One warrant for my hope lies in the fact that we, with only six percent of the world's population, have today more trained scientists and engineers than all the rest of the world put together.

The application of new scientific discoveries and new inventions is always a business speculation. It is based on venture capital and plowing in of profits until production is in full bloom.

There are two obstructions in the path of such a solution of our economic problems. The first is unintelligent taxation and the second a coming national famine in technologists. I could enumerate a dozen other destructors but I said this would not be a p o l i t i c a l treatise.

An Example

There is no better exhibit of what ill-considered taxation can do to our economy than our non-ferrous metal industry in the West. That industry is founded wholly on venture capital and the plowing in of profits until a mine is equipped and producing. Today such venture capital from individuals is itself undermined, and taxation prevents the n e c e s s a r y plowing in. That is not theory; it is a fact. Twenty years ago there were about 3,000 operating non-ferrous metal mines in the Rocky Mountain area. Today there are only a few more than 1,000. I recently made a canvass of the operators of many of the large mines which were developed in a more favorable economic climate. I asked a simple question—Could this enterprise have ever been developed and equipped under present taxation and other restrictions on freedom? The answer was NO in every case but one, and that case had been a bonanza so rich as to defy even the tax-collector. But today even in most of these surviving enterprises the government takes from the stockholder about $85 out of every $100, earned before taxes, and if he received the remaining $15, there would be no fund left to plow into constantly needed improvements to treat decreasing grades of ore.

From it all, the nation is becoming short of these domestically produced metals.

By stimulated scientific research and invention looking to new engineering methods we can reduce costs and thus do something to aid this industry. But more intelligent taxes on mines such as those in other countries would sustain the industry. It would be cheaper than government subsidies.

The same problems apply to the other industries where venture capital and plowing in are their characteristics.

But there has arisen an alternative application of new ideas which bodes little good to our society. The established industries can and do undertake such risks in their fields. They can write off their losses against taxes, and the venture costs nothing. The inventor, the prospector or the individual has little chance of this relief. The consequence is that existing enterprises absorb the new discoveries and inventions. They grow in size and monopolistic strength but the opportunity for the individual to establish his independent and competitive business is greatly diminished.

We Are Running Short of Engineers

We have in our profession another great national problem. We do not have enough engineers in incubation to carry on the nation's work. We need 60,000 new technologists a year to supply national needs. Our engineering

graduates have dropped from 50,000 in 1950 to 38,000 in 1951, and the students in training indicate less than 30,000 next year. Yet our universities have ample facilities to fill the demand.

One reason for this drop is that a young mechanic with three years of training, during which he is paid, can earn more take-home pay after taxes than a young engineer with six years of training and three years more of experience. Too often the financing of engineering training is too expensive for his dad. And with increased tuition and living costs it is more and more difficult for boys by off-time work to make their way through college as many of you did.

The answer must come from the industries. They must consider their responsibility to aid promising boys. For it is upon such boys that future existence of industry depends.

The Engineering Profession

But there are more cheerful subjects for discussion among engineers. I have reviewed them many times in the past.

Within a little more than my lifetime, the training of engineers has risen from apprenticeship to a trade or secondary technical schools to the dignity of a university-trained profession.

As indicative of the distance the engineers have risen in public repute, I might recall that some years ago while crossing the Atlantic, I took my meals at the same table with a cultivated English lady. As we came into New York harbor, at breakfast she said: "I hope you will forgive my dreadful curiosity, but I should like awfully to know what is your profession." I said that I was an engineer. Her involuntary exclamation was: "Why, I thought you were a gentleman."

The engineer has a high privilege among professions. He has the fascination of watching a figment of his imagination emerge with the aid of science to a plan on paper. Then it moves to realization in cement, metal or energy. Then it adds to the security and comfort of homes.

Engineering training by our universities has other great values to the country than its industrial consequences. It instills character in those who would join its ranks, for high ethical standards are the essential of all professions. Technology without intellectual honesty does not work. Construction without conscientiousness soon crumbles. Here is the invocation of veracity in a world sodden with intellectual dishonesty. These are the reasons you have seen no engineers before the Kefauver Committee. Nor in the headlines which these days pour forth from Grand Juries and District Attorneys' offices. The engineers' main appearance in public is only sit on juries and committees for reform.

From the work of the engineers comes the lifting of men's minds beyond the depressing incidents of the day. And here is the rejuvenation of spirit and confidence in the future of our country.

In any event you will agree that the engineer is an antidote to evil and the bearer of blessings. Even including his antidote to inflation.

In closing, let me repeat a statement from a good engineer of just exactly four hundred years ago. He referred to the mining engineers but his general tolerance is warranty for its applications to all engineers. "Inasmuch as the chief callings are those of the moneylender, the soldier, the merchant, the farmer, and miner, I say, inasmuch as usury is odious, while the spoil cruelly captured from the possessions of the people innocent of wrong is wicked in the sight of God and man and inasmuch as the calling of the miner excels in honor and dignity that of the merchant trading for lucre, while it is not less noble though far more profitable than agriculture, who can fail to realize that it is a calling of peculiar dignity?"

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The Television Camera

by Paul LaViolette, E.E. '56

Among the many complex marvels that the television industry of today offers, perhaps the most amazing is the eyes of the television system—the television camera. The present day television camera is the outgrowth of years of experimentation.

It was in 1873 that a telegraph operator named May noticed that some resisters he was using made of the element selenium actually changed their resistance value when exposed to sunlight. This was the first evidence recorded of an action which later became known as the photo-electric effect.

For years after this many scientists speculated and experimented with selenium in the hopes of using it to transmit scenes from one place to another. In 1877, Senlecq proposed a rather crude scheme for television by using a type of "mosaic." Those sections of the mosaic on which light fell allowed current flow and those sections without light allowed none, thereby forming electrical current very roughly equivalent to the image. Soon after this in 1884, a German named Nipkow came forth with a scanning disc composed of a series of holes that made but one complete circle on the disc and at the end of the one turn one end was an inch closer to the center. The disc was rotated and the rays of light passed through the holes into the mosaic screen generating varying currents due to the density of light. The gradually diminishing radius of the holes caused the entire surface of the mosaic to be covered in one revolution.

This method, although ingenious, had many difficulties: the focal point of the light on the mosaic was too large, there were too few holes in the disc to cover the mosaic equally, and synchronizing the receiver discs permanently was almost impossible.

It wasn't until early in the thirties that the mechanical system was abandoned completely and a faster, more efficient electronic one introduced. The cathode ray tube, the basis of the new method had been suggested for use in television as early as 1911; but as there was no way of amplifying its generated weak signal, the whole method had been shelved and forgotten until DeForest perfected his amplifier vacuum tubes. With the cathode ray tubes it was possible to increase the scanning lines from sixty lines at twenty "frames" (pictures) per second to 525 lines at 30 frames per second. Since lines have a great deal to do with the clearness of the picture, as will be explained later on, this alone would have been sufficient to make obsolete the older method.

The Cathode Ray Tube

The cathode ray tube is simply an electron gun that fires a small thin stream of electrons from one end of the tube to a screen on the other end which fluoresces under the impact of the electrons. This stream of electrons is capable of being deflected by a magnetic field and by setting up two such fields —a North and South and an East and West—the beam can be directed to any part of the screen. After removal of the electron stream to another part of the screen the spot hit by the electron retains its fluorescence for a brief period.

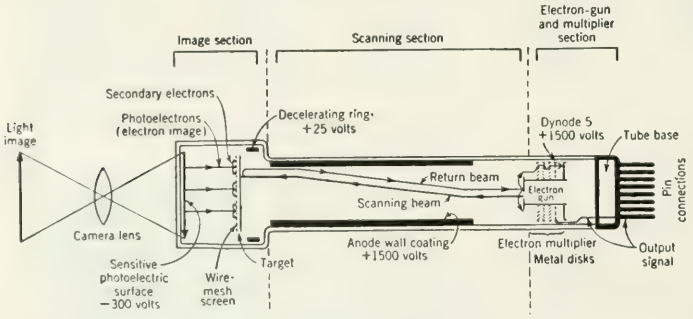

Figure 1. Image orthicon. (Cut courtesy McGraw-Hill Book Co., Basic Television-Principles and Servicing by Bernard Grob, 1949)

If the pictures in this magazine were examined with a magnifying glass it would be noted that they are composed of neat little rows of minute dots varying in density depending on whether that section of the picture is light or dark, the number of lines determining the clearness of the picture. By applying a "saw tooth" voltage on the line (East-West) field coils and a regular 60 cycle sine voltage on the frame (North-South) field coils, the screen can be covered or "scanned" just like reading a printed page. The resulting picture would be much like the ones in this magazine varying in density only to indicate light or dark. As the frame changes thirty times a second, action can be simulated by the succession of slightly different pictures on the screen much in the manner of a motion picture.

The Iconoscope

The Iconoscope developed by V. K. Zworykin for RCA is a modified version of the cathode ray tube. The tube is as pictured in Figure 2. Light enters the tube through a glass plate and strikes the mosaic plate. The mosaic is composed of several thin sheets of mica. On the front of the sheets are millions of tiny globules of cesium silver oxide. The back of the mica is coated with colloidal graphite which is the signal plate and is connected directly to an amplifier on the outside.

Each silver globule is insulated from its neighbor by mica and has a diameter of about 0.001 inch. Light hitting the silver globule (which is photo-sensitive) causes it to emit its electrons in a ratio directly proportional to the incident light and thereby assumes a positive charge. All the globules react according to the light imposed upon them and an electrical charge is imposed on the plate equal to the image projected on it.

Off to one side well clear of the incoming light is the cathode ray tube without its sensitive screen. The electrons fired from the gun now fall on the positively charged globules of silver

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Aircraft development is such an integral part of our national life that young graduates can enter it with full expectation of a rewarding, long-term career. Boeing, now in its 36th year of operation, employs more engineers today than even at the peak of World War II. Its projects include guided missiles, research on supersonic flight and nuclear power for aircraft.

Boeing engineering activity is concentrated at Seattle in the Pacific Northwest, and Wichita in the Midwest. These communities offer fine fishing, hunting, golf, boating and other recreational facilities. Both are fresh, modern cities with fine residential sections and shopping districts, and schools of higher learning where engineers can study for advanced degrees.

There are openings in ALL branches of engineering (mechanical, civil, electrical, aeronautical, and related fields), for **DESIGN, DEVELOPMENT, PRODUCTION, RESEARCH and TOOLING.** Also for servomechanism and electronics designers and analysts, and physicists and mathematicians with advanced degrees.

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salt. The electrons being negative are gathered as needed by the silver and the resulting condenser action with the graphite causes an impulse signal which is immediately relayed to the amplifier. From there it is magnified and sent out as a strong electrical interpretation of the image.

The Image Orthicon

The Image Orthicon also developed by RCA is a refinement of the Iconoscope (Figure 1). Besides the advantage of being more compact, it has the electronic advantage of needing less light and is not liable to "shading" caused by secondary emmission in the mosaic. The need for less light gives this tube a greater range of uses over the old type.

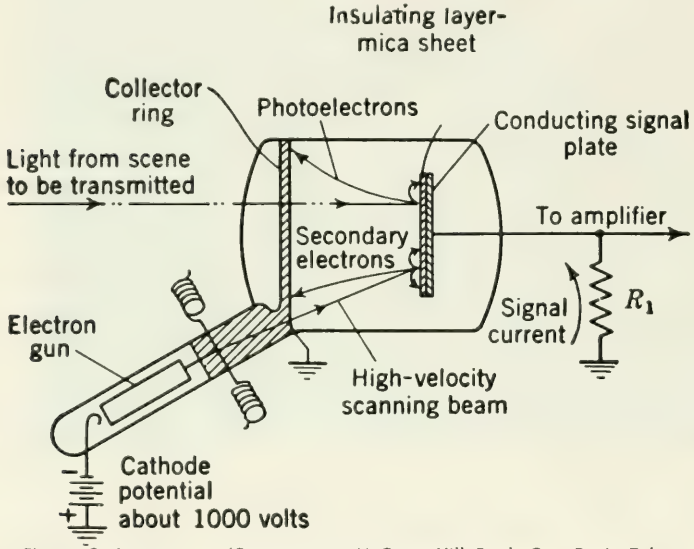

Figure 2. Iconoscope. (Cut courtesy McGraw-Hill Book Co., Basic Television-Principles and Servicing by Bernard Grob, 1949)

The camera shown on these pages is an RCA TK11A which employs the Image Orthicon and is adaptable for both field and studio use.

The Lens

The lenses used on the television camera are ordinary camera lenses with the exception of the Zoomar Lens. The Zoomar eliminates the switching of one lens to another as the object being televised makes rapid changes in range. The lenses are all fixed on a rotary drum that is controlled in the rear of the camera by a handle. The Orthicon tube is brought into focus by moving it back and forth on a sliding carriage mounted to the chassis. The slide is easily moved by a focus handle on the outside of the camera.

To facilitate better framing and as a necessity for quick focusing, each camera has its own viewer which is a small television screen in front of the operator mounted in a removable section on top of the television camera. By watching the viewer the operator always has a clear picture of the image he is transmitting.

The Camera in Action

The T.V. camera on taking a picture transmits the image to controllers in the control unit, where all the remote control operations of shading, aligning and directing take place. The Switcher is the director who takes from the several cameras the image that is the most satisfactory and puts it on the monitor. Here it is double watched for faults and relayed to the transmitter for broadcast by micro-wave link or co-axial cable.

The television camera in the studio is an easier affair to operate than in the field. Here it is moved on dollies and the signal is transmitted to control rooms of comfortable operating size. In the field, however, the heavy equipment is mounted on tripods and the switching and monitoring is done in tight-fitting, uncomfortable trucks. Also there is the difficulty of getting the signal back to the studios to be rebeamed to the transmitters for broadcast. This last difficulty is overcome by micro-wave links mounted on top of trucks or telephone cables connected directly with the studio. As it is set up now, until a more remote wireless method of transmitting can be perfected, the field unit is tied overclosely to the studio.

S.A.E. DEBATE

by Tom Madden
Gen. E. '54

At their monthly meeting on March 23 the Central Illinois Section of the Society of Automotive Engineers had a very interesting and quite different type of program. It was a debate in which a team composed of SAE members from the Illinois chapter met a similar team from Bradley University on the question *Resolved: That hydraulic torque converters are an essential component of future power transmissions.* Each debate team participating in this annual event, held this year for the third time, was composed of five members plus an alternate. Three of them gave five-minute constructives and the other two presented three-minute rebuttals.

The men participating were all mechanical engineering students active in school activities. Ronald Goe, present chairman of the local SAE chapter, was the only debater making the trip who was on last year's squad. The group was accompanied by Professor John C. Miles as faculty advisor. Preparation for the debate was made at about ten weekly meetings held in the Mechanical Engineering Building Lounge.

This year the Illinois chapter defended the negative side of the debate question concerning hydraulic torque converters. Arguments used by the Illini in supporting the manual transmission as contrasted to the hydraulic converter were economy, simplicity, and compactness. On the other hand, Bradley, in supporting the hydraulic mechanism, argued smooth operation, easy to drive, and more time to drive (no need for removing hands from the steering wheel to shift.

The men making the trip are always justly rewarded for their efforts. Last year they all received offers of employment—along with a very hearty meal. The TECH commends these men for their work in the advancement of engineering knowledge, and hopes they may win many more plaques such as the one now adorning the west wall of the Mechanical Engineering Lounge.

You can't hold a man down without staying down with him.

—Booker T. Washington

* * *

An apology is better than an explanation—and quicker.

—William Feather

* * *

A chip on the shoulder is the heaviest load a man can carry.

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See your Placement Officer today for the details on Lockheed's Aircraft Training Program for engineers, as well as the better living conditions in Southern California.

If your Placement Officer is out of the illustrated brochures describing living and working conditions at Lockheed, write M. V. Mattson, Employment Manager.

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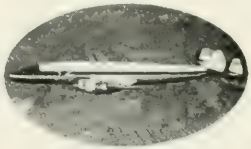

The Super Constellation – larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

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The jet of the future – the plane you will help create – belongs here.

This plane – which exists only in the brain of an engineer like yourself – is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.

OIL IN THE BASIN

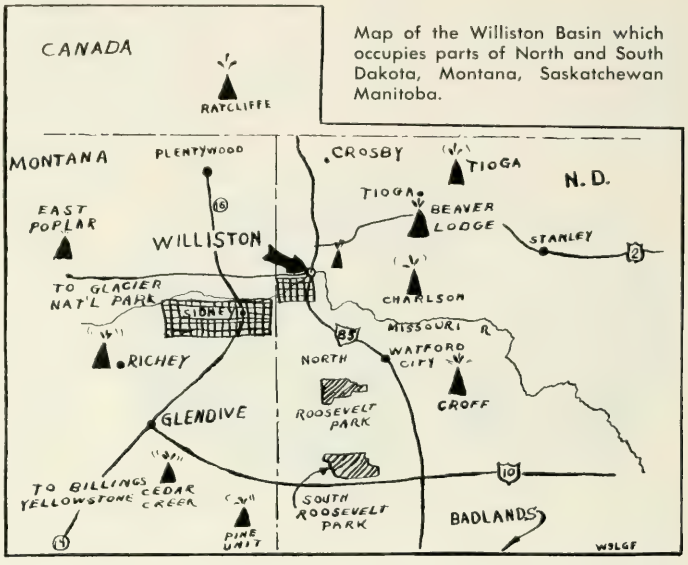
by Daniel J. McGowan, I.E. '55

Each discovery of a technical frontier has been accompanied by tremendous opportunities ever since man began to discover such frontiers. And equally true is the fact that few people recognize the value of a discovery when it is made. This article is intended to present you with information on a recent discovery, and it is your author's desire that you exploit it fully.

Geography books describe the great plains states as sparsely populated farm lands. The people who live there depend upon the whims of weather for their existence. In times of drouth those acres become arid miles of burned wheat and suffocated flax. In winter they are buffeted by high winds and extreme temperatures and are buried annually by tons of snow. And yet there is something worthy of that area, for below the sometimes seared farmlands is one of the greatest oil fields in the world!

The region is called Williston Basin because it centers upon Williston, North Dakota, (in the northwest corner of the state). Geologically, the Williston Basin is a huge underground structural depression, occupying the western two-thirds of North Dakota, overlapping into eastern Montana and parts of South Dakota and stretching into Saskatchewan and Manitoba. The depression is mainly of the Cretaceous system overlain by strata of Tertiary system carrying numerous lignite seams. (See accompanying table.)

Less than three years ago it was only suspected that gas and oil in commercial quantities could be found in Williston Basin. Today that neighborhood is being converted into a major producer of petroleum. Three years of work changed a general area into a place on the map with more than 174 producing wells and 20 new oil fields.



Map of the Williston Basin which occupies parts of North and South Dakota, Montana, Saskatchewan Manitoba.

The first well was brought in July 13, 1951, in a barnyard by the Amerada Petroleum Corporation. This event flashed a signal to the entire oil industry and within hours the streets of Williston were crowded with wildcatters, lease buyers and those who wanted to "get in on the ground". Within days thousands of acres of land were under oil and mineral lease to petroleum's leaders. Oil boom fever indeed ran high.

What followed in later months is recorded in the journals of industry. Prices of stocks in oil soared and even Wall Street held its breath at the turn of events. Capital, labor and technical ability poured into the area and more oil gushed out.

Total production in the state of North Dakota alone for the period from January 1, 1952 to November 30, 1952, amounted to 1,249,094 barrels of oil. 1951 was a year of discovery; 1952 showed promise of immense development. An estimated $34,000,000 was spent for geophysical work on the U. S. side of the Basin in 1952. During that year, operators drilled 240,035 feet of wildcat wells at a cost of more than $2,500,000 in South Dakota.

Standard Oil of Indiana, recognizing the potentialities of Williston Basin, will begin construction next May of a 30,000 barrel-per-day refinery. The

SYSTEM	SERIES	FORMATION	THICKNESS (feet)	CHARACTER
Cretaceous	Montana	Fox Hills Sandstone	85- 200	Yellow sandstone with marine shells
		Pierre Shale	1070-1950	Blue shale with marine shells
Tertiary	Eocene	White River	40- 400	Coarse sandstone with pebbles and clay
		Lance	700- 900	Cannonball and fresh water limestone

A segment of the table prepared by Arthur Leonard for the *Quarterly Review* of the University of North Dakota. It presents geological information on part of the Williston Basin, where oil was discovered in July of 1951.

THE DU PONT DIGEST

A GROWING FIELD—

Instrumentation

Modern manufacturing trends at Du Pont bring ever-increasing opportunities for technical men

Do you think of instrumentation as applying only to work in electricity and electronics?

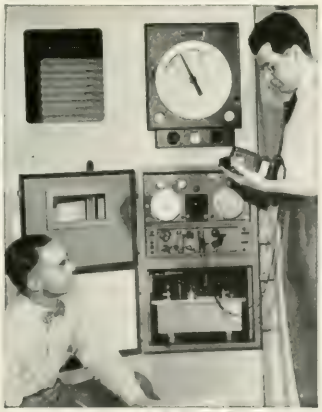
Or would you also include problems in chemical processing, materials of construction and materials handling, as well as application of equipment — both mechanical and hydraulic—for measurement and control systems?

At Du Pont, instrumentation is applied to widely diverse areas of manufacturing operations. It calls for many different technical backgrounds. In a typical instrument group there may be men whose formal training has been in mechanical, chemical, electrical or metallurgical engineering, or in physics, etc.

Instrumentation is becoming more and more important in the chemical industry. In fact, many of today's processes and products would not be possible without modern measurement and control systems. The trend toward continuous processes means challenging and constantly increasing opportunities for instrumentation men.

Du Pont's instrument program includes research, development, design, and supervising installation of process control equipment. Some of the work is done in the central Engineering Department at Wilmington. However, most of the major plants across the country now have their own organized instrument groups.

Fred R. Struder, *B. Metal W., Rensselaer P.I. '50, examines a pressure strain recorder with Allen R. Furbeck, E.E., Princeton '39.*



Richard G. Jackson, *B.S. in Ch.E., Columbia '42, and Gregory L. Laserson, Ph.D. in M.E., Columbia '49, test an infrared gas analyzer.*

Paul D. Kohl *(left), B.S. in M.E., Purdue '46, checks the assembly of an experimental control instrument.*

So you may visualize the scope and diversity of the work, here are examples of instrumentation recently developed and designed by Du Pont technical men:

1. A device to measure flow of approximately 30,000 lbs. per hour of gas at more than 10,000 p.s.i. To give 1.2% accuracy and be responsive to flow-changes of five cycles per second.

2. A device to monitor continuously 1200 similar temperatures. Equipment to record temperature and sound alarm at a deviation of 1°C. from desired point.

3. An automatic control system to maintain a predetermined pressure-temperature relation in a large-batch autoclave during spontaneous reaction between two chemicals.

Thus it can be seen that Du Pont instrumentation is limited to no single avenue of engineering. Men with an aptitude for the work get experience in many phases of the Company's technical activities—and an excellent background for positions in management and administration.

ASK FOR "Chemical Engineers at Du Pont." New illustrated booklet describes initial assignments, training and paths of promotion. Just send post card to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware.

DU PONT

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Watch "Cavalcade of America," on Television

works is to be located about three-quarters of a mile north of Mandan, North Dakota on a 900 acre site. Principal products to be manufactured there are gasoline, kerosene, heater oil, diesel fuel, furnace oil, power fuel, and industrial fuel oil. Products will be shipped from the refinery by rail, truck, and thru a products pipeline to Moorhead, Minnesota. At Moorhead a connection will be made with Standard's northwest products pipeline originating at Whiting, Indiana.

When completed by 1955, the refinery will include modern equipment for crude oil distillation, catalytic cracking, polymerization, vapor recovery, finishing, and shipping.

As I said before, this discovery presents tremendous opportunities to us, for here is an entirely new technical area still in its formative stages. Williston Basin is a pretty display as it grows today, because it will need engineers, all kinds of them; chemists, to do old jobs and research in new fields involving petro-chemical techniques; businessmen and executives to administer operations; and thousands to keep the economy going.

I SPEAK MY PIECE

by Walter G. Olesky, L.A.S., Pre-Journalism

You engineers! You inventors! Have you ever stopped to think of the problems, of the social consequences evolved from your *brain children?* Right now one of your progeny — namely *TV* — is being condemned daily. This robot, this monster has become the whipping boy, the alibi, the excuse and, at once, the cause of many of our personal, local and public ills — homework . . . housework . . . chores . . . bedtime . . . juvenile delinquency and crime . . . Just watch the papers! As an "embryo" journalist, may I contribute my piece?

How is television influencing the youth of America? What are the social consequences of television? The answer is relatively simple.

One growing problem, however, is television's time-consumption without sufficient educational reward. You may argue that this is problematical only to the indiscriminate viewer.

Television has made constant advancement in its effort to supplement routine entertainment programming with educational fare. With the birth of television channels devoted entirely to education, educational programming seems even closer to becoming a reality.

Meanwhile, worthwhile selection is the responsibility of every person old enough to choose his TV entertainment discriminately; it is also the responsibility of parents to control the selection of TV shows for children.

There are scores of worthwhile TV shows regularly that are interesting and instructive, concerned directly and incidentally with the broad task of education. The viewer can sprinkle his diet of murder, pathos, comedy, and dry-gulching with a nightly side-dish of educational TV if he wishes.

It is difficult to see the scandalous implication of a major Chicago newspaper's survey of Christmas shows for children, which counted an appalling number of murders offered to child viewers. Couldn't that survey be taken at any time during the year with resultant figures of murders, lynchings, fistfights, and suicides? If parents are appalled as such news, they should be interested enough to take a hand in the selection of programs which their children view, and insist upon a well-balanced diet of television viewing, both constructive and entertaining.

For me there's nothing wrong in watching my favorite blood-and-thunder dramas on television. We college oldsters who can remember radio used to listen to the same old blood-and-thunder blueprint stories (and a lot of us imagined the gory murders a lot better than they show us on TV); so far no one has attributed my retarded mentality to poor old radio.

The curse of television is in the lazy fellow it makes me. Naturally I'm justified in getting my first few months' worth out of TV. But that's the dangerous time. That's the time during which my habits are formed. That's the best time to decide what my TV future will be—chained to it? — Can father watch the good shows, and become too relaxed to turn it off when the dull shows come on? Is he going to forget his hobbies of building or repairing things, or reading a book about something he always wanted to know?

Can mother keep up with "Guiding Light" and "Hawkins Falls, pop. 6,200" and her baking, mending, and ironing at the same time? Does mother turn TV into her baby sitter?

What of the children? Television is taking away the play habits of children. Outdoor games are being discarded in favor of parlor watching. Summer streets are too often barren of roller skaters, marble-players, hop-scotchers, winter streets too often barren of belly floppers and snow-ball fighters. Parlor pallor and lethargy stalk the house.

Television is a thief, walking boldly into living-rooms, stealing imagination, vitality and time. If we don't defend ourselves by discriminate viewing, we might as well get out the popcorn and padded pillows and call it a day.

In the event that you're asking yourself: "What IS worthwhile on TV?", here are a few suggested shows. All of the following shows cannot be good, but they are an effort on the part of TV program directors to satisfy the "thinking" mind as far as sponsors will allow.

From a private survey, Sunday is the day with the most educational TV shows. Now remember that the man said about quantity and quality, and find the shows you like best.

At noon, Sunday, WNBQ offers "Youth Wants To Know", with distinguished political and educational guests.

"How Does Your Garden Grow," with John Ott, discussing horticultural developments, such as "Growing Plants Under Fluorescent Light", WNBQ, 1 p. m.

"American Forum of the Air", discussion of political issues, WNBQ, 1:30 p. m.

"Omnibus" (Ford Foundation Workshop) takes you into the realm of world-interest, from Shakespeare to Lincoln, old movies of the Wright Brothers' early flights, and new movies of helicopters in war, etc., WNBQ, 3:30 -5 p.m.

"Meet the Press", interviews with notables, WNBQ, 5 p.m.

Edward R. Murrow's "See It Now" (taking you inside USA and around-the-world), WBKB, 5:30 p.m.

"Press Conference", panel interviews, WGN-TV, 6:30 p.m.

"Victory At Sea", film series, story of sea power during World War II, WNBQ, 9:30 p.m.

Monday begins a five-day TV trip to Chicagoland colleges with "Illinois

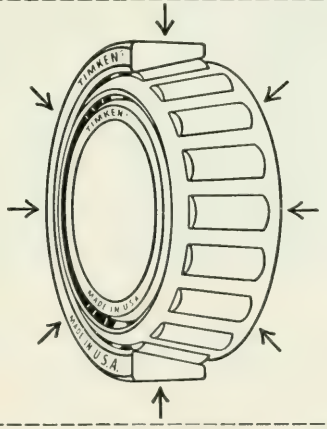
Another page for **YOUR BEARING NOTEBOOK**

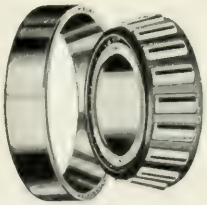
Largest two-crawler shovel keeps going on TIMKEN® bearings

Designed to meet the trend toward larger excavating and hauling units, Marion Power Shovel Co., built a new 10-cubic yard 191-M shovel with a production potential of over 600,000 yards a month. To keep it on the job every day of the month with minimum maintenance, Marion engineers equipped it with Timken® tapered roller bearings at all vital points. Timken bearings carry radial and thrust loads in any combination. Their true rolling motion and smooth finish practically eliminate friction. By keeping housing and shaft concentric, they make closures more effective. Lubrication time and costs are cut.

All loads are the same to a TIMKEN bearing

The tapered design of cup, cone and rollers of Timken bearings enables them to take radial loads, thrust loads, or any combination of the two from any direction. Timken bearings do away with the need for auxiliary thrust bearings or plates. They simplify design, cut costs, save space.





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TAPERED ROLLER BEARINGS

Want to learn more about bearings?

Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For a copy of the 270-page General Information Manual on Timken Bearings, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ⓪ AND THRUST —⓪— LOADS OR ANY COMBINATION ✳

Tech", WBKB, 2:30 p.m.

"Johns Hopkins Science Review", WGN-TV, 7:30 p.m.

"Dr. Fixum", for the household genius, WENR-TV, 10:30 p.m.

Tuesday continues the educational series from "Lake Forest College", WBKB, 2:30 p.m.

"Life Is Worth Living", the best of the general education shows on TV, deserves special consideration from viewers because its star, Bishop Fulton J. Sheen, credits viewers with having enough mental power to follow him through non-political, non-sectarian, but Christian education. WGN-TV, 7 p.m.

"What's the Great Idea", WBKB, 7 p.m., brings demonstrations of new inventions to the TV audience.

"Wisdom of the Ages", WGN-TV, 8:30 p.m. speaks for itself.

Wednesday's only offer is "Loyola University", WBKB, 2:30 p. m.

Thursday's only offer is "University of Illinois", WBKB, 2:30 p.m.

Friday, "Roosevelt College", WBKB 2:30 p.m.

"Walt's Workshop", a popular long-run TV show with Walter Durbahn, instructs viewers in wood craft, WNBQ, 7:30 p.m.

"The World Is Yours", travel show, whets the appetite by movies of places like the Indies, Rio, New Orleans, etc., done in good style with smooth lectures and appropriate background music. WGN-TV, 8:30 p.m.

Saturday is represented by "Farm and Home Time", WBKB, 12 noon.

"Jet Pilot" brings the intricacies of aviation down to laymen's terms, WNBQ, 5:30 p.m.

(We hesitate to add "Mr. Wizard", but for the kiddies, Don Herbert masters the magic of science; WNBQ, 6 p.m.)

"Farm Town, U.S.A.", WBKB, 8:30 p.m. rounds out Saturday's fare, and completes a week's educational television offerings.

Try some of those on your TV dial, and if you don't like any of them, then take out the popcorn and padded pillows, and save a seat for me.

The Gullible Public and TV

by Ronald Swallow, E. Physics '56

The quality of many TV sets is sharply declining. In recent years because of strict competition and public demand for a "cheaper" set, manufacturers have been forced to "cut", that is, reduce the number of parts. As a result, the parts are overworked, and tube and circuit failures are twice as frequent as they were only a few years back.

During the first years of the TV industry, a set was a masterpiece of scientific know-how. A set was designed to perform for years without trouble. Not only were its electrical circuits designed under mathematical calculations, but little room was left for improvement on design. The tubes performed their functions well within their range of safe operation. No expense was spared to give the best, clearest and sharpest picture on the screen.

The pioneers in the manufacturing of TV sets had little competition during the first year. Their sets were, of course expensive; but they were good sets. One by one their former competition in radio switched to the TV industry, and before long the market was full of different makes and models. Each manufacturer produced a set slightly cheaper than his competitors and did so by leaving out one or two parts without apparently affecting their function. This cutting has been going on for years and the result is beginning to show up on the operation of the set.

A manufacturer can "cut" on the number of parts in his set in various ways. He may redesign several circuits by letting one tube do the work of two. This is the most common way of reducing the price of a set although the function of the set is not affected to any noticeable extent. After a year has passed, however, the trouble begins. Not only do the overworked tubes go out one by one, but most of the parts in the circuit have shifted in their respective values causing the set to be "sensitive" to operate. The picture becomes wavy and unstable. This trouble could have been prevented by an Automatic Gain Control circuit which strengthens the impulse signals that hold the picture stiff and straight. The circuit, however, is usually left out because the wavy condition does not start causing trouble till the manufacturer is free of financial or guarantee relations with his customer. Consequently, unless the maker has unusual pride in his product, he does not seem to have obligation to account for and to correct this difficulty.

Tube cutting is first started in the low-voltage supply circuit. In the well-designed sets two power tubes are required to change the AC voltage from the low-voltage transformer to DC. Instead, one tube is used. Lately, selenium rectifiers are being used — not only to replace the remaining tube — but to eliminate the $15.00 low voltage transformer. However, the filaments of all the tubes that had previously received their voltage from the low voltage transformer, consequently had to be hooked up in series across the 110 AC line. Under such conditions the tubes too often have a tendency to burn out. In addition, the selenium rectifiers in many sets fail within a couple of years, giving the owner a fairly high repair bill; had the transformer been used with a rectifying tube, it would have cost him perhaps half as much.

Another common area for tube cutting is in the high-voltage circuit. Where two expensive, more durable tubes had been used, one less expensive and less durable is transplanted. One of the most common tube failures in a TV set is this tube. By making this change in the circuit, the manufacturer is able to save approximately $10.00 in the selling price of his set. In the long run, the owner pays $25.00 in repairs.

A third area of cutting is in the amplifying stages where the weak signal, picked up by the antenna, is greatly amplified or strengthened to the point where it is able to give a clear and sharp picture on the screen. In this case several tubes are left out, reducing the overall amplification of that particular stage. Less signal means less picture detail. However, to the average buyer a new TV set picture looks just like any other and only the price seems to affect him.

The remaining tubes in the amplifying stage are usually overloaded in order to assure their proper function. If one tube weakens and the overload is not able to make up for its drop in emission, the whole stage is not able to function until the tube is replaced. Previously the

A MESSAGE TO COLLEGE ENGINEERING STUDENTS

from A. C. Monteith, Vice President in Charge of Engineering and Research, Westinghouse Electric Corporation

There's room to grow at Westinghouse

It's natural that you sometimes wonder about the "elbow room" in the field of engineering. Even though the past half century has witnessed great technological developments, they are only a prelude to the things to come. We have barely scratched the surface in the fields of engineering development and research. And that, most certainly for you, should mean there *is* room to grow.

But first you must find the right starting point—a company which will give you the opportunity you want in your career. Westinghouse offers you this kind of opportunity, for it is a growing company in a dynamic field. Energy is our business. Here at Westinghouse, well planned orientation and training, continued education, position rotation, and management development are all offered to provide you a favorable climate in which to grow.

To those who are prepared and willing—whether inclined toward research, engineering, manufacturing or sales—opportunities with Westinghouse are limitless.

G-10252

For information on career opportunities at Westinghouse, consult Placement Officer of your University, or, send for our 34-page book, *Finding Your Place in Industry*.

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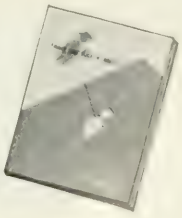
Mr. L. J. Dunlap
District Educational Co-ordinator
Westinghouse Electric Corporation
Merchandise Mart Plaza
Chicago 54, Illinois



YOU CAN BE SURE...IF IT'S

Westinghouse

tubes in well-designed sets were able to drop off in emission to the point where they were nearly dead, and still function satisfactorily.

The lack of "real life" detail pictures on all TV sets is not the fault of the manufacturers. The detail of the picture is determined by the number of horizontal lines across the screen. Originally experimental TV sets were designed with twice the number of lines across the screen and therefore twice the detail. The FCC (the Federal Communications Commission) set up a standard by which there would be less picture detail. The reason for this is that the picture detail or the number of lines across the screen is directly proportional to the band width of high radio frequencies required for each TV channel. In order to have twice the detail that we have today, manufacturers and transmitting stations would find it necessary to use a band width of 9 megacycles rather than the present 4.5. This would reduce the number of channels by half. Since 4.5 megacycles give us 13 channels, 9 would permit only 6. However, it will not be long before the UHF (Ultra High Frequency) stations start broadcasting. They will permit the opening of 40 more channels; thereby the FCC can double the picture detail on TV sets. At present this is only a possibility.

We cannot accuse the manufacturers of complete guilt in this let-down in the quality of today's average TV set. Manufacturers are responsible, however, for an educational program (via advertising) whereby the non-scientific-minded public can learn to discriminate by knowledge as well as by price. Only by such ethical procedure can scientists protect their inventions and give to Americans the best that electronics can offer.

A first grade teacher fresh from college was taking over class for the first time. Upon entering the class she noticed a nasty word on the blackboard. (Signed only by the Phantom). She didn't know what to think or do. So she said, "Now children let's fold our little hands, put them on our little desks, and put our little heads down on the desk. Then the person who wrote this word on the blackboard will come up and erase it." So they all folded their little hands, and put their little heads on their desks. All was quiet for a short spell, then there was a thump, thump, thump, thump of little feet, a pause, and a thump, thump, thump of little feet going back to the desk. After everything was quiet again the teacher said, "Now let's see if the word has been thoroughly erased." So they all looked to the board. Much to their surprise they found written there, a nastier word, and "The P h a n t o m strikes again."

"We Take What We Can Get"

by Wallace Snyder and Robert Schultz, E.E. '56

The personnel manager of a company which annually hires hundreds of engineering graduates recently stated, "We take what we can get." Today, where trained manpower is concerned, industry can not afford to be proud. The fact that industry is suffering from a lack of trained engineers and scientists is universally realized. Industry needs 30,000 new engineers every year for normal replacement and growth. In 1951, there was a shortage of 60,000 engineers. This condition is expected to continue for several years.

Due to industry's ever-increasing demands, and this present shortage of engineers, our chances for a job after graduation are practically assured. Even the man at the bottom of the class, in most cases, find an excellent position. Our future looks bright if we're concerned only with getting and holding a job.

However, most of us feel that merely getting a job and receiving a check every week is not sufficient. We want to "go somewhere" in the engineering field. We want promotions, salary increases, or even an occasional pat on the back. We want to climb—not plod along in a rut.

The obvious questions at this point is: What qualifications are necessary to achieve a reasonable amount of success as an engineer? To answer this it is necessary to know what industry expects of the new engineer.

Technical ability is an indispensible quality. It is the basis on which most engineers are hired and, in later years, it will prove to be one of the determining factors toward advancement. It is usually the man with the well-rounded background in physics, mathematics, and engineering principles who advances quickest. Narrow specialization in a particular field of engineering is not recommended by industry since the versatility of the new engineer is too limited. Industry desires men whose technical background provides a firm foundation for a technical ability which increases with the passing of time. Perhaps this accounts for on-the-job training programs in many of the larger companies.

The ability to write, read, and speak effectively is deemed valuable in engineering as well as in other fields. Since the engineer works with people in addition to objects, he must be able to express himself clearly and accurately at all times. Ideas without the ability to communicate are not of much use. As a result, most industrial personnel men feel that English and literature courses are just as important as math courses.

The knack of understanding and being able to work with people is necessary to the engineer. For this reason industry beams on such college courses as philosophy, psychology, and similar humanistic-social programs. The antagonistic engineer has no place in industry, regardless of his technical ability, unless he plans to isolate himself in the dark corner of a remote laboratory. Obviously the qualities of co-operation and understanding cannot be fully gained from textbooks and lecturers. Extra-curricular and social activities help to convert classroom facts into working knowledge.

If the engineer is going to gain promotion and leadership, he must be willing and able to assume responsibility. Otherwise, he will find that he stays at his job while engineers with less seniority move to higher positions. Responsibility every potential engineer can practice in his college years. Extra-curricular activities and sports by themselves will not guarantee success, but they can give the student co-operative and leadership opportunities.

Leadership and organizational abilities are recognized essentials to a brilliant career in any field. These characteristics are high on the list of traits required of men who are selected for management in industry. Since 40% of management is recruited from the ranks of engineers, can we afford to lose a chance or a moment to develop these cited qualities?

So, in these days when industry's motto is "We take what we can get," we potential engineers are virtually assured of jobs. Getting the job? Where will we be at 35? at 45? What ruts lie in wait for us? The "side" learning and experience in leadership, cooperation and organization can make or break the most skilled technician in engineering.

The preceding article is the result of conferences with personnel men at the Chicago offices of Bell Telephone and Hallicrafters Radio Corporation. Our reading deals with General Electric policies as well as those of Allis-Chalmers, Dupont and the Studebaker Corporation.

Richard J. Conway, Lehigh '51, selects Manufacturing Engineering at Worthington

RICHARD CONWAY checks cutting tool with machinist before milling a pump casing.

After completing his general training which brought him in contact with all departments, Richard J. Conway decided that manufacturing engineering was his field. He says, "I chose the Manufacturing Engineering Department after completing my general training at Worthington because as a graduate in Industrial Engineering I can learn the practical aspects of my field while applying theory I learned in college.

"The personnel of this department work together as a team toward the solution of the numerous problems which arise daily. We have the cooperation of all other departments in the corporation in getting the necessary facts pertinent to the solution of these problems. In the course of our day it may be necessary for us to meet the Plant Manager, Chief Engineer, Comptroller, several department heads, clerks, foremen, machinists and many others throughout the company.

"I have contributed to the solution of many problems handled by this department including metal spraying, machining procedures, purchasing new equipment and designating proper dimensions to obtain desired fits between mating parts.

"I enjoy my work because I'm doing the work I want and my formal education is being supplemented with practical knowledge gained from the tremendous wealth of knowledge available to me at Worthington. I know from personal contact with many other departments in the Corporation that Worthington can and will find their young engineers a spot which will give them the same opportunities as have been afforded me."

When you're thinking of a good job, think *high*—think *Worthington*.

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

WORTHINGTON

The Sign of Value Around the World

An open letter to the College of Engineering:

Once again we have successfully put on another Engineering Open House. Thanks to your efforts, the Open House was a real success which will lead to bigger and better Open Houses in the future.

Hundreds of people spent many hours working on the Open House this year. And now the natural question arises, "What has been accomplished by all this effort?" The answer to this question are many.

High school students have received a glimpse of what engineering is, and can better choose their future careers. The rest of the campus has been shown what a potent force the College of Engineering is in the educational system of the University of Illinois.

The general public has seen the vast potential of engineering.

Above all, you, the students and faculty of the College of Engineering, have worked together to produce an exposition of which any University in the country could be proud. So long as this can be done, engineering will remain a living, vital force at the University of Illinois.

Sincerely,

Bob Schrader,
General Chairman,
1953 Engineering Open House

to the

ELECTRICAL ENGINEER

or

PHYSICIST

with an interest in

RADAR

or

ELECTRONICS

Hughes Research and Development Laboratories, one of the nation's leading electronics organizations, are now creating a number of new openings in an important phase of their operation.

Here is what one of these positions offers you:

THE COMPANY

Hughes Research and Development Laboratories, located in Southern California, are presently engaged in the development and production of advanced radar systems, electronic computers and guided missiles.

THE NEW OPENINGS

The positions are for men who will serve as technical advisors to government agencies and companies purchasing Hughes equipment—also as technical consultants with engineers of other companies working on associated equipment. Your specific job would be essentially to help insure successful operation of Hughes equipment in the field.

THE TRAINING

On joining our organization, you will work in the Laboratories for several months to become thoroughly familiar with the equipment which you will later help users to understand and properly employ. If you have already had radar or electronics experience, you will find this knowledge helpful in your new work with us.

WHERE YOU WORK

After your period of training—at full pay—you may (1) remain with the Laboratories in Southern California in an instructive or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the Hughes representative at a military base in this country—or overseas (single men only). Compensation is made for traveling and moving household effects, and married men keep their families with them at all times.

YOUR FUTURE

In one of these positions you will gain all-around experience that will increase your value to our organization as it further expands in the field of electronics. The next few years are certain to see large-scale commercial employment of electronic systems. Your training in and familiarity with the most advanced electronic techniques now will qualify you for even more important future positions.

How to apply:

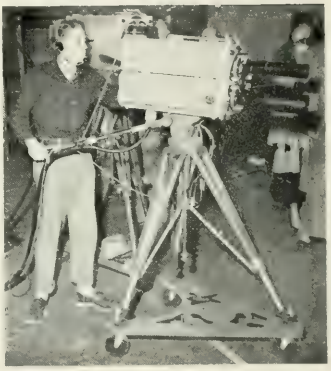
HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Scientific and Engineering Staff
Culver City, Los Angeles County, California

See your Placement Office for appointment with members of our Engineering Staff who will visit your campus. Or address your resumé to the Laboratories.

Festival of Contemporary Arts

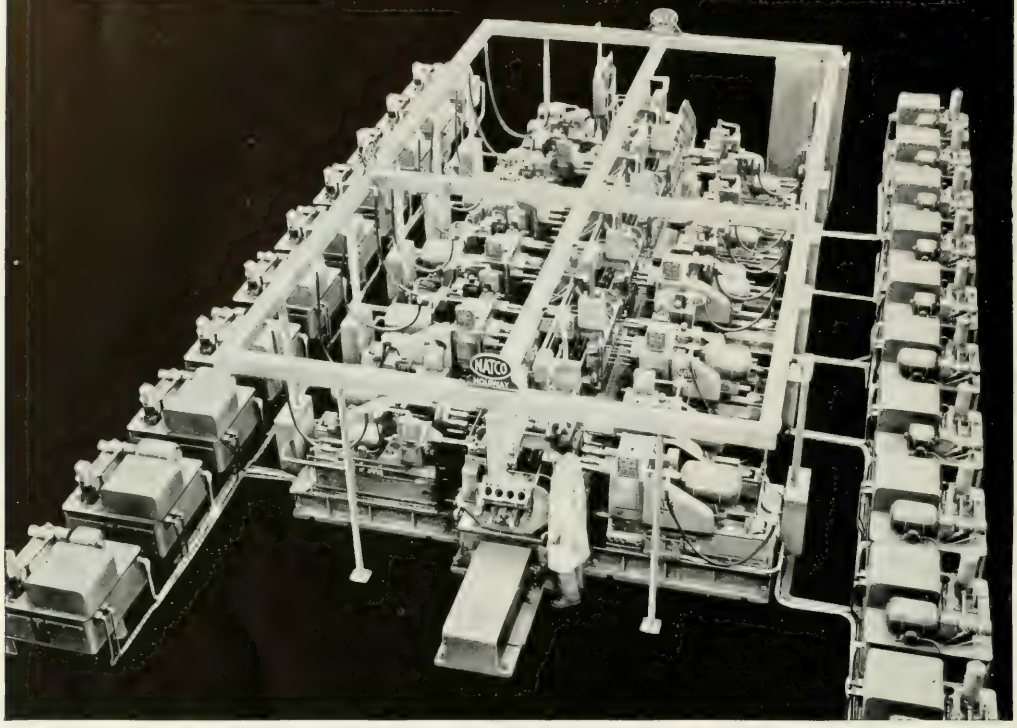


Above: The plan of Chicago as submitted by architects from the Chicago Institute of Architects working with the University. Below: Control room at the University television station. Right: Cameraman demonstrating operation of a television camera.

Above: University of Illinois television studio and control room, east side of the stadium in the East Great Hall. Below: Demonstration of operations inside the control room. Left: Modern Dance techniques at the Festival of Contemporary Arts.

Photos by Armand Andre
Met. '56
Technograph Staff
Photographer

COULD YOU *ENGINEER* THIS MACHINE?



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IT'S A YOUNG MAN'S *Aviation* WORLD

McDONNELL *Aircraft*

IT'S A YOUNG MAN'S COMPANY

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The aircraft world is a rapidly changing, competitive one. In it, youth is an asset, for it requires a young flexible mind to visualize the practicality of today's research data and evolve from it the aircraft of tomorrow. It is this type of vision that has characterized the achievements of the McDonnell engineering team—a team that places the accent on youth. The average age of M.A.C.'s engineering staff is thirty years.

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You can live in beautiful suburban St. Louis and still be near the McDonnell plant at Lambert Field, 11 miles from the city. Enjoy the comforts of "county" living, with easy access to "big city" shopping, entertainment, medical, and educational facilities. Our Housing Representative will assist you.

Build Your Future With A Company . . . Young In Years, Young In Spirit And Ideas

For more information about our company and our community, see your Placement Officer. Ask about the McDonnell Graduate Study Plan and our engineering booklet "Your Future Has Wings."

LAWRENCE A. WEEKS

Chief Stress Engineering Airplanes

(B.S.C.E.—Iowa State College—'43)

(M.S. Applied Mechanics Washington U., St. Louis—'50)

Larry will soon receive his renewal service pin as a M.A.C. engineer. His present responsibilities would be a burden for a man twice his age. At 31, Larry supervises a large group of engineers in the structural design of all M.A.C. airplanes.

CALVIN J. BLATTNER

Design Engineer Missiles

B.S.A.E.—Notre Dame U.—'46

(M.S. Applied Mechanics Washington U., St. Louis—'52)

Cal started his career with M.A.C. in September 1946. He now supervises an engineering group concerned with dynamics analysis of fire control systems. Although only 27, he has found time to earn his Master's Degree in Applied Mechanics.

PAUL T. HOMSHER

Project Engrg. Test Engineer Airplanes

B.S.A.E. Purdue '45)

Paul has been a member of our Airplane Engineering staff since April 1947. He is now Project Flight Test Engineer on the F3H Demon airplane. In this position he supervises several other engineers programing and analyzing flight test data. Paul is 30 years old.

ROBERT W. FALCONER

Design Engineer Helicopters

(B.S.A.E. -Univ. of Illinois -'48)

Bob, who recently celebrated his 28th birthday, joined the McDonnell team in August 1948 as an Assistant Research Engineer. Presently, he is in charge of the jet engine design for helicopters.

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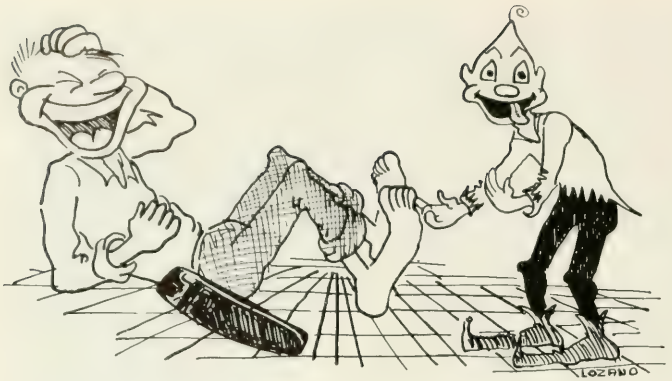


TECHNOCRACKS

edited by Phyllis Krone and Freddi Wallk

A man was perched atop of one of Atlanta's highest buildings, contemplating suicide, and a policeman had made his way to the roof to try and persuade the man not to jump. "Think of your mother and father," pleaded the officer.

"Haven't any."

"Think of your wife and children."

"Haven't any."

"Well, think of what your girl friend might think."

"I hate women."

"All right, think of Robert E. Lee."

"Who's he?"

"Go ahead and jump, you damn Yankee!"

* * *

For the first time in her life little Nellie watched a cat carrying her kitten by the nape of the neck.

"Shame on you," cried the youngster. "You ain't fit to be a mother. You ain't even hardly fit to be a father!"

* * *

An after dinner speaker had gone on and on for what seemed several hours. Finally, one member of the audience slipped away from the table and out into the hall. There he met a fellow banqueter who had slipped out earlier.

"Has he finished yet?" he asked.

"Yes," replied the one who had just come out, "a long time ago, but he won't stop."

* * *

Little Patricia was watching her mother apply cold cream to her face, and asked, "What's that for, Mommie?"

Mother answered, "Why, this is to make me beautiful."

After the cold cream had been removed with tissues, Patricia sadly remarked, "Didn't work, did it?"

A feminine tourist pointed to a decorated skull in a show case: "Do you know whose skull it was?"

Tired Mexican Guide: "That is the skull of the Emperor Montezuma."

The Giddy One then pointed to a smaller skull in the same case: "Who was that?"

Guide (with perfectly straight face): "That, Madam, is the skull of Montezuma when he was a little boy."

* * *

Overheard on the bus: "Well, if her husband is a self-made man, he certainly hired awfully cheap labor."

* * *

Speaking on the dangers of modern food, the speaker pointed a finger at a harassed looking listener and demanded, "What is it that we all eat at some time or another, that is the worst thing imaginable for us? Do you know, sir?"

Softly came the answer from the little man, "Wedding cake."

* * *

It has developed that a true friend is one who visits you when your television is on the blink.

* * *

In many small garages the service men identify cars by the names of their owners. When repairs are needed, or special services required — other than storage—this practice leads to some interesting notes in the day book of orders. To-Wit:

Mrs. Ellis won't start.

Give Miss Jackson some alcohol. Two quarts ought to hold her.

Something wrong with old man Pitt's wiring.

Mrs. Wendham's fenders bumped. Not responsible.

Wash Miss Jenkins.

Luck is what happens when preparation meets opportunity.

* * *

There is a close relationship between hard work, a light heart and a clear mind.

* * *

No one grows old by living — only by losing interest in living.

* * *

Mockery is the weapon of those who have no other.

* * *

A great deal of water can be gotten from a small pipe, if the bucket is always there to catch it.

—*National Safety News*

* * *

When a man is in earnest and knows what he is about, his work is half done.

* * *

Doctor: You're the father of triplets.

Politician: Impossible! I demand a recount.

* * *

Ted: How did you break your leg?

Ed: I threw a cigarette in a manhole and stamped on it.

* * *

Woman: Are you the man who gave my son a dog?

Man: Yes, I am.

Woman: Well, you'd better come over and take them all back.

* * *

A certain businessman had the habit of leaving his umbrella at his office. One morning as he was going to work he sat next a young lady in the trolley car, and as he rose to get off he absentmindedly picked up her umbrella.

"Pardon me," she said, "but this is mine." The man was quite embarrassed, naturally.

That night he decided to take all his umbrellas home with him from the office.

When he got in the trolly car, there sat the same young lady. She leaned forward and said in a low tone:

"I see you did pretty well today after all."

* * *

Remember that old woman who saved her wedding dress for her daughter? Now she has a daughter who saves her wedding dress for her next wedding.

* * *

"It says here in the paper that in New York a man is run over every half hour."

"My! my! Poor fellow!"

* * *

Teacher: How old would a person be who was born in 1920?

Smart Kid: Man or woman?

* * *

When you buy things for a song, watch out for the accompaniment.

ILLINOIS TECHNOGRAPH

MAY, 1953

.25

Only STEEL can do so many jobs so well

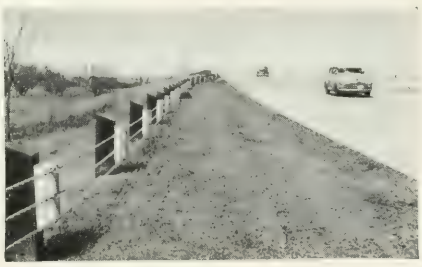
OPPORTUNITIES WITH U. S. STEEL

If you're thinking about what you're going to do after graduation . . . if you're interested in a challenging, rewarding position with a progressive company . . . then it will pay you to look into the opportunities with United States Steel. Your placement director can give you more details, or we'll be glad to send you the informative booklet, "Paths of Opportunity." United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

Stainless steel walls mark the handsome skyscrapers of Pittsburgh's Gateway Center. Panels are made of corrosion-resistant Stainless Steel, backed up with lightweight concrete reinforced with welded wire fabric. These are attached to the building frame quickly and easily. Multi-story building walls go up with astonishing speed—in this project, at better than a floor-a-day rate. And because these wall panels weigh less, the weight of supporting structural members is also reduced, resulting in lower building costs.

They work high to dig deep. Steel derricks like this symbolize one of America's most vital defense treasures . . . oil. To help bring up the "black gold" from its ancient, miles-deep resting places, U. S. Steel makes drilling rigs, steel drill pipe, casing and tubing, cement, pumps, wire lines, and tough alloy steels for the drilling bits that can bite through the hardest rock.

Photo—Standard Oil Co. (N. J.)



Taking no chances is a good rule to follow on modern highways. Drive carefully—the life you save may be your own. This U·S·S American Multisafty Cable Guard saves many lives, too. Over 140 proving ground impact tests, using cars of all types, have demonstrated that this type of highway guard provides greater protection at high speeds.

This trade-mark is your guide to quality steel

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OIL WELL SUPPLY . . TENNESSEE COAL & IRON . . UNITED STATES STEEL PRODUCTS . . UNITED STATES STEEL SUPPLY . . *Divisions of* UNITED STATES STEEL CORPORATION, PITTSBURGH
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THE ILLINOIS TECHNOGRAPH

volume 68 number 8

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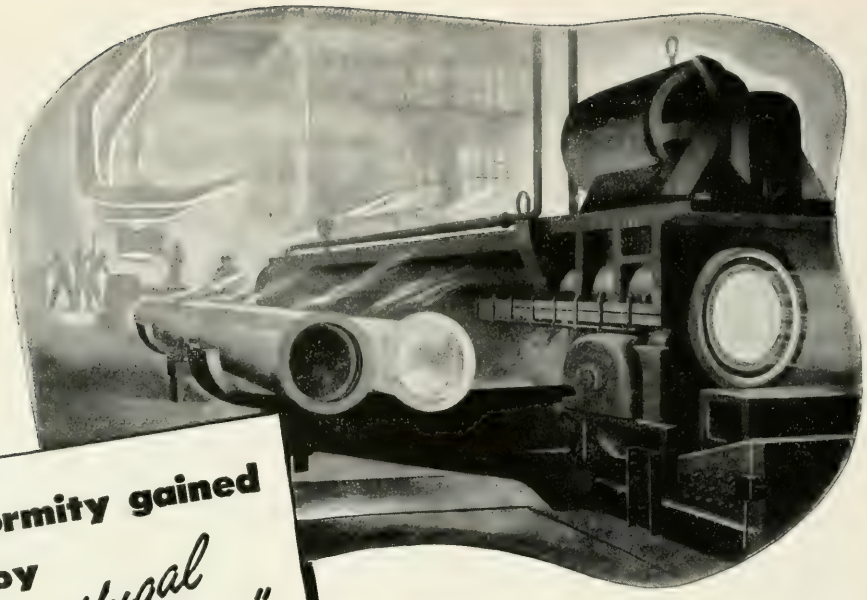
our cover

The steel industry, a very important aspect of the American scene, is depicted in this painting by Weimer Pursell for the National City Bank of New York who furnished the color plates.

our frontispiece

Electromagnetic models are a new method of determining transient voltages. Shown is a three-phase transformer and its electromagnetic model, aside of which is its inventor, P. A. Abetti. (Cut courtesy General Electric Company)



Uniformity gained by "Centrifugal Casting"

The great majority of cast iron pressure pipe produced today is cast centrifugally, in metal or sand-lined molds.

When this mechanized process was introduced 27 years ago, its potentialities for improved production controls were evident. For human fallibility was largely replaced by machine accuracy based on scientific principles.

The improved production controls made possible by the centrifugal casting process have long since been realized. Hundreds of millions of feet of centrifugally-cast-iron pressure pipe are now in service. All of this pipe is more uniform in metal structure, in wall thickness, and in concentricity, than pipe not centrifugally cast.

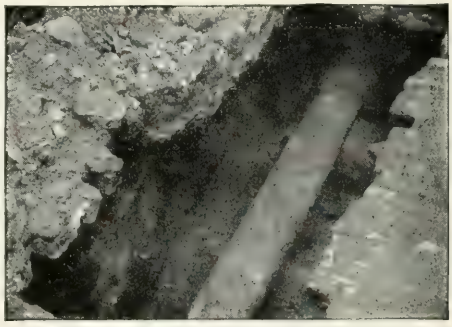
Better production control means better pipe; it results in greater uniformity of quality.

Production controls in cast iron pipe foundries start almost literally from the ground up with inspection, analysis and testing of raw materials; continue with constant control of cupola operation by metal analysis; and end with rigid tests of the finished product.

By metallurgical controls and tests of materials, our members are able to produce cast iron pipe with exact knowledge of the physical characteristics of the iron before it is poured into the mold of a centrifugal casting machine.

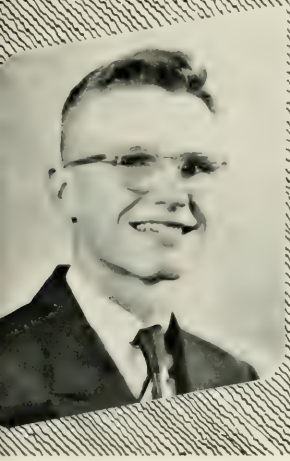
Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction.

Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Avenue, Chicago, 3, Illinois.



Section of 114-year-old cast iron gas main still in service in Baltimore, Md.

CAST IRON PIPE SERVES FOR CENTURIES



Fly Ash in Concrete

by Robert M. Koscielny, C.E. '54

Winner of the 1953 Dolly Gray award presented by the Mid-West Ready-Mixed Concrete Association was Robert M. Koscielny, a junior in Civil Engineering. The paper, which must be on a subject relating to ready-mixed concrete is presented below.

It has long been known that certain finely divided siliceous materials which possess no cementitious value will, in the presence of moisture, react chemically with lime, ($Ca(OH)_2$), at ordinary temperatures to form insoluble compounds possessing cementitious properties. Such a material is a pozzolan.

The four principal reactive compounds which are present in portland cement are tricalcium silicate, dicalcium silicate, tricalcium aluminate and tetra-calcium aluminoferrite. When portland cement combines with water, lime is liberated from some of these compounds. This lime combines with sulfates forming highly expansive and unstable calcium sulfate. Thus, by use of certain puzzolans it is possible to fix the lime into a stable and useful combination.

This introduces the important problem of selecting a pozzolan which is most suitable for the job. In this selection the properties which should be considered are strength, durability in resisting freezing-thawing and sulfate action, workability, shrinkage, and elasticity. Equally important is the net cost of the product.

The solution to this problem, at least here in the midwest, seems to be a pozzolan, which is produced here in large quantities—known as fly ash. Fly ash is a fine powdered residue formed from the burning of powdered coal and is collected as a by-product in large power plants. This is collected by precipitators from the flue gases. It is of prime importance to note that there exists differences in chemical composition, but the principle compounds are silica, alumina, iron oxide, and lime. In all cases there exists some carbon. The carbon content is the critical compound. It is universally accepted that fly ashes of carbon contents that are less than 10 per cent, and of high fineness produce a greater activity and are a greater contribution to the strength of mortars and concretes.

It has been determined, that except for the carbon content, the differences in chemical composition have no marked effect upon the properties of concretes. In general, fly ashes of low carbon content are finer than those of high carbon content. The effect of the carbon content of fly ash upon compressive strength is shown in the table and graph below.

It is seen that fly ashes of low average carbon content exhibit a much higher strength at all ages than did the group containing the higher average carbon content.

A direct comparison of the effect of fineness was made between fly ashes having the same carbon content, and it was found that the cement containing the finer fly ash exhibited considerably higher compressive strength at all ages from 7 days to 1 year.

The graph and table further explain that at ages of 7 to 28 days the compressive strength was higher for the concrete containing no fly ash than for any of the concretes containing fly ash. However, at the ages of 3 months and 1 year the compressive strengths of the concretes containing fly ashes of low carbon content and high fineness were considerably higher than that of the ordinary portland cement concrete.

In an effort to eliminate this deficiency it has been found that if it is desirable to produce a concrete mix of 28-day strength equal to that of a comparable concrete without fly ash, the amount of fly ash used must be larger than the amount of cement replaced. For example, if 94 lbs. of cement is to be removed, as much as 150 lbs. or more of fly ash must be added to produce a concrete having a 28-day strength equal to the mix without fly ash. The amount of fly ash greater than 94 lbs. may be compensated by a reduction in sand.

This fact brings up a most important item—that of the replacement of cement by fly ash. The optimum replacement of cement depends on the nature and fineness of the fly ash, the richness of the mix, the type of cement, and the properties of the concrete desired. From a wide variety of tests and comparisons it has been concluded that the optimum percentage of replacement for most mixes may be 25 percent or more if a fly ash of low carbon content

Table I—Compressive Strength of Standard-Cured 1:5.6 Concrete Containing Fly Ashes of Different Carbon Content and Fineness, General-purpose Portland Cement; Portland-Pozzolan Cements.

Pozzolan Per Cent of Cement	Per Cent Carbon in Fly Ash	Specific Surface of Fly Ash	Ratio Pozzolan Cement	W/C of Concrete by Wt.	Compressive Strength, lbs. per sq. in.			
					7 days	28 days	3 mos.	1 yr.
None	—	—	1600	0.43	4040	5310	5790	6810
Ave. for 3 fly ashes low in carbon	2	2750	1830	0.41	3520	4900	6090	7180
Ave. for 5 fly ashes high in carbon	22	2150	1710	0.49	2770	4030	5080	5870

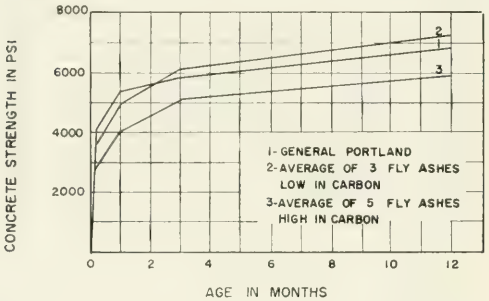
Copied in part from "Effect of Fineness and Carbon Content of Fly Ash on Properties of Concrete and Concrete Containing Fly Ash" by R. E. [illegible], R. W. Carlson, J. W. Kelly, and H. J. Davis, Mass. Inst. of Tech.

and moderately high fineness is used. Such a replacement will produce a concrete which will have a compressive strength equal to or exceeding that which will be produced by the corresponding portland cement concrete.

Fly ash seems to contribute relatively more to the strength of lean mixes used in the construction of massive structures such as dams or bridge piers. Replacements as high as 50 percent have resulted in concrete strengths that were not unduly low and a substantial reduction in the heat of hydration making the possibilities of the use of high-replacement fly ash cement appear very attractive and for many purposes far superior to ordinary portland cement. Its current use in the construction of the Hungry Horse Dam proved satisfactorily that the use of fly ash has an important place in modern construction.

It is desirable that the amount of water required to produce concrete of given consistency be low. In this regard the desirability of a fly ash of reasonably low carbon content and high fineness is increased, in that, fly ash differs from most other pozzolans. Ordinarily a portland-pozzolan cement requires more water than the corresponding portland cement. This is illustrated in the table which shows that the water requirement was less for the average of 3 fly ashes low in carbon than for the corresponding port-

COMPARISON OF COMPRESSIVE STRENGTH OF CONCRETES CONTAINING GENERAL PORTLAND AND FLY ASH CEMENTS



land cement. Thus, the advantages of a low water requirement are added. These are: improved strength, watertightness, volume constancy, and improved workability on the basis of equal water-cement ratios.

Concretes in general tend to shrink upon drying. This characteristic is particularly undesirable in thin structures subjected to long drying conditions, since excessive shrinkage results in cracking. Drying shrinkage is related to the reduction of moisture content. It may, perhaps, be acceptable to assume that concretes containing fly ash cements possess finer pore space, moisture is less readily withdrawn from exposed surfaces. It is an accepted fact that the shrinkage of ordinary structures may be no more, and in some instances less, than for corresponding structures containing portland cement. A fact of further interest, is that generally the higher the strength of the concrete the less the contraction in fly ash cements.

In regard to the ability of concrete to resist the action of freezing and thawing, sulfate or sea water, and weakly acid or low pH waters, fly ash cements of low carbon content and high fineness seem to be equal and in many cases superior to ordinary portland cement. In the case of freezing and thawing, tests have shown that the compressive strengths of specimens treated were slightly less on the average for fly ash cements than for portland cement. However, a fly ash (Chicago fly ash) with the lowest carbon content and of moderately high fineness exhibited a higher strength than did the portland cement. Further, if air entrainment is used, the resistance to freezing and thawing is increased in both portland cements and fly ash cements to the extent that resistance to freezing and thawing has become almost unimportant.

Fly ash cements seem to be far superior to ordinary portland cement in their resistance to the action of aggressive waters. Thus, making the use of fly ash very desirable for concrete structures such as harbor works, sewerage or industrial tile, and bridge piers.

All fly ash cements generate less heat of hydration than portland cement. The rise in temperature due to this heat may cause stresses which are likely to produce cracks even in walls having a thickness no greater than 2 or 3 feet. Thus, again, indicating the necessity and desirable results obtainable by use of fly ash in massive concrete structures. In fact, concretes containing 50 per cent replacement by fly ash generate less heat than any other of the low heat cements employed in construction.

Tests determining the modulus of elasticity of concretes indicate that at early ages the modulus of elasticity for fly ash cements was slightly less than for portland cements. At later ages, it was somewhat higher. However, the differences were only slight and could hardly be large enough to become a factor of design.

Considering only the preceding discussion and noting the advantages of fly ash as a pozzolan, it is difficult for the author, at least, to see reasons for any resistance to its use. Perhaps, some resistance is induced because, as yet, long time tests have not been completed. Although, reports on tests now underway at various utilities, Federal bureaus, several state highway departments, and other such concerns have universally been good. Of course, there is a natural tendency to resist changing or tampering with a satisfactory product or process. Some poor results have been obtained with coarse high carbon content fly ashes. This fact indicates the necessity of an A.S.T.M. specification for fly ash. However, an A.S.T.M. Committee, C-9 on Concrete and Concrete Aggregates, is currently in the processs of evolving a specification for fly ash as an admixture.

However, when the items of cost of materials and saving of cement are added by the ready-mix concrete producer, these resistances seem to lose their significance. For instance, figures for the Hungry Horse Dam show that its use led not only to substantial improvements in the quality of the structure, but also to a tremendous savings of approximately $1,680,000 in the cost of materials used.[2] This saving is offset slightly by the cost of handling the extra material.

In ready-mix plants now handling bulk fly ash the installation and cost of equipment to handle the fly ash has ranged from 4 to 6 thousand dollars. This equipment includes a silo and the necessary valves and conveyors to handle the fly ash. The cost of transportation is usually greater than the cost of fly ash. Assuming a portland cement replacement of 25 percent, and the cost of fly ash delivered to be $5.00 per ton, and the cost of portland cement delivered to be $15.00 per ton. The savings here in total cost of material per one hundred tons of portland cement used without fly ash is $250.[3] On the basis of a six bag mix the cement without fly ash would cost $4.50 per cubic yard of concrete. If a 25 percent replacement is used, the cost of cement per cubic yard of concrete would be only $3.35. This represents a savings of $1.05 per cubic yard of concrete.

The conclusions regarding the suitability, quality, and economy of the use of fly ashes of moderately high fineness and low carbon content in concretes follow:

1. Compressive strength is increased considerably.
2. The heat of hydration is reduced.

[2] R. E. Blanks, "Fly Ash as a Pozzolan," *Journal of the American Concrete Institute*, Vol. 21 (May, 1950), pp. 701-7.

3. The water requirement for a given workability seems to be nearly the same or slightly less.

4. Resistance to sulphate action and aggressive waters is increased.

5. Modulus of elasticity is affected, but is not of sufficient magnitude to be a factor of design.

6. Shrinkage is no more and in many cases less.

7. Resistance to freezing and thawing is slightly reduced.

8. More air entrainment admixture must be added to obtain the same amount of air entrainment.

9. The cost of materials is reduced a tremendous amount.

10. Less portland cement is required.

11. Richness of the mix has little or no effect on the contribution of fly ash to the compressive strength.

From these conclusions it seems only logical to state that the use of fly ash has definitely improved the concrete product, and does have an important place in modern construction.

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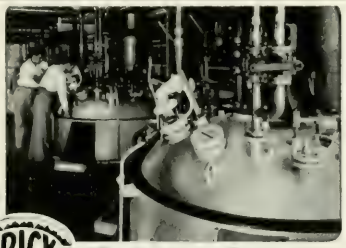
Synthetic Rubber Industry Increases Output with



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Research by...

The Physics

collected and edited by C. Han Sah, Eng. Physics

To conduct a program of research successfully, regardless of the field, at least two items are obviously needed: (1) equipment or tools which are reliable and accurate and (2) competent personnel to organize and supervise the research. At the University of Illinois, physicists are fortunate in that they find neither item lacking. In fact, Illinois is one of the very few places where there is a large group of instruments available so that a complete investigation can be carried out in almost every field of nuclear physics. Also, many of the staff members of the Physics department are considered to be among the world's foremost authorities in their respective fields.

Everyone has probably heard about the University of Illinois's betatron at one time or another. A great deal of public interest has centered about this important tool of physics since it is the largest type of accelerator of its kind in the world. However, it would indeed be a mistake for one to think that it is the only (or even the most important) center of research activity. Actually, there are many programs which are being carried out simultaneously in widely scattered areas on the campus, all of which are of great importance. In order to cover these various research programs, we must necessarily limit ourselves to a glimpse of only the salient features of each.

NUCLEAR MAGNETIC RESONANCE AND NUCLEAR ALIGNMENT

Dr. C. P. Slichter is presently conducting an experiment on nuclear magnetic resonance. In order to understand the fundamental principles underlying this experiment, one must realize that the nucleus of an atom can be considered to act like a tiny magnet. When a nucleus is placed in a static magnetic field, the interaction of its magnetic moment with the static field gives rise to a phenomena known as the nuclear Zeeman effect. The "spectral lines" which are emitted by the excited nucleus split up into several components known as Zeeman levels. Transitions between the different Zeeman levels can be produced by alternating magnetic fields whose frequency in typical cases, is a few megacycles/sec. Since the frequency depends, among other things, on the strength of the nuclear magnet, one can in this manner measure nuclear magnetic moments. When transitions occur between the Zeeman levels, "spectral lines" are in many cases observable. These lines are of considerable interest since the line breadth results from interactions of a nucleus with its environs. Usually one is using a liquid or solid sample, in which case these environs include other nuclear magnets, electrons either tightly bound to the nucleus or (as in metals) wandering through the solids, etc. These interactions are strongly characteristic of the particular sort of material (solid, liquid, metal, ionic crystal, etc.) containing the nucleus. Interpretation of features of the nuclear resonance enables one to use the nuclear magnets as tiny probes to study liquids and solids. Such things as coefficients of self-diffusion, onset of internal motion in solids, etc. have been studied in this manner. Currently at Illinois, work is being carried on studying resonances in the alkali metals (where self-diffusion affects the resonances dramatically) and in super-cooled liquids. A new program to study magnetic resonance of electron magnetic moments has recently been started.

Doctors J. C. Wheatley and R. D. Hill are presently engaged in determining nuclear spins and magnetic moments by a method known as nuclear alignment. Although this is a difficult method, it may be the only way of determining these quantities directly for radioactive nuclear levels.

The present equipment consists of a cryostat using adiabatic demagnetization. A magnet developing 15,000 gauss in a volume of approximately 100 cc has been used for the demagnetization experiments. The cryostat is jacketed with liquid N_2, liquid H_2, and liquid He, in that order. Temperatures of 0.03 degree Kelvin have thus far been achieved. Four scintillation counters for simultaneous gamma ray intensity measurements are set up around the nuclear-aligned single crystal.

RADIOACTIVITY RESEARCH PROGRAM

Radioactivity experiments are being conducted by Doctors R. D. Hill, P. Axel, I. Bergestrom and H. Frauenfelder. These experiments are directed at determining the properties of excited states of nuclei. The interest in these properties is widespread for two reasons: (1) the experimental techniques are sufficiently developed so that many characteristics of excited states can be determined unambiguously. (2) There are several partially successful theories which can be tested or revised on the basis of regularities which can be found in the experimental data.

There are many experimental measurements which can be made to help determine the properties of nuclear energy levels. For any given radioactive nucleus, the use of several of these experimental techniques can give a complete picture of the radioactive decay.

The equipment which is used by this group includes five different types of beta ray spectrometers plus a wide assortment of scintillation detectors and proportional counters. There is also auxiliary electronic equipment which makes it possible to detect radiations simultaneously.

With this equipment it is possible to determine the following data, from which the properties of nuclear energy levels can be inferred: (1) The energy, intensity and energy distribution of positive or negative beta particles. (2) The energy and intensity of conversion electrons. (3) The energy and intensity of gamma rays and x-rays. (4) The simultaneity (or coincidences) of any pair of radiations or the time delay between these radiations. (5) The relative angular distribution of two radiations which occur successively.

RESEARCH PROGRAMS AT THE PHYSICS RESEARCH LABORATORY

The Physics Research Laboratory houses the three University of Illinois betratons. Although the 300 Mev. betatron is the one which one hears about most often, much important research has also been carried out utilizing the 80 Mev. and 20 Mev. machines. The laboratory is well equipped for experiments with scintillation counters, photographic emulsions, cloud chambers, and chemical separation techniques. The machine shop and glass shop facilitate construction of equipment.

20 Mev. Betatron

The 20 Mev. Betatron is an instrument for accelerating electrons up to accurately known continuously variable energies. This betatron can be used in any one of three different ways: (1) with a standard x-ray tube, it can pro-

Department

and Henry Kalapaca, N.R.L.

duce a source of x-rays. (2) the electron beam can be used to bombard internal targets directly or (3) the electron beam can be removed from the betatron and utilized outside the machine.

Research with the 20 Mev. machine can be also classified into three groups. (1) A great deal of the work has centered about the detailed study of how photons (bundles of light energy) are absorbed by the nuclei of uranium atoms and what happens to these nuclei after the absorption. (2) By placing suitable targets directly into the electron beam, it is possible to obtain sufficient intensities of radioactive materials to obtain good sources for the study of decay schemes. Dr. Duffield in collaboration with others, has studied the decay scheme in In, Ag, Ta and W and at present, is studying the isomers of Mo^{91} and has plans to look at Vanadium. (3) The electrons from the betatron can be focused, by means of a magnetic lens, to a small spot at about 10 feet from the machine. This beam has been used for preliminary studies of electrodisintegration of nuclei but primarily for studies on the scattering and energy loss of electrons in matter. The most recent work with the electron beam has been that of Goldwasser, Mills, and Robillard who have obtained very nice data on the comparison of the energy loss in gases and solids of the same composition.

The 80 Mev. betatron operates with one burst of x-rays every three seconds or less frequently. As such, it is valuable for cloud chamber studies and for testing apparatus.

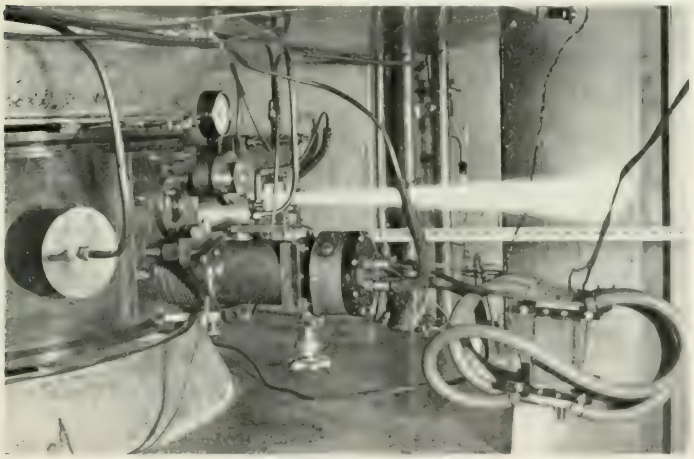
300 Mev. Betatron

The 300 Mev. betatron provides a very intense and highly collimated beam of x-rays, the maximum energy of which can be controlled accurately and conveniently between 100 and 340 Mev. Measurements of small cross sections, of angular distributions, and of energy dependence of nuclear processes thus can be performed with some precision.

Several members of the betatron staff are studying the structure of nucleons through meson production by x-rays in hydrogen. (Nucleons are the particles which constitute the nuclei of the atoms). By measuring the energy and angle of the meson or of the recoil nucleon, one can completely determine the dynamics of the process. With the uses of liquid hydrogen targets, Doctors Goldwasser and Bernardini have already made considerable progress in this area of research.

The liquid hydrogen targets have also been used by Whalin, Dwight, Hanson, Keist, Smith and Koester to study the photodisintegration of deuterium (heavy hydrogen) at high energies. Photodisintegration studies of heavier nuclei reveal much information about nuclear structure, and is also being studied by several staff members.

In the field of electrodynamics, Fisher has done a cloud chamber experiment on high energy scattering of positrons and electrons.



Ten mev deuterons emerge from the U. of I. Cyclotron. (Photo courtesy of Nuclear Radiation Laboratory)

NUCLEAR RADIATION LABORATORY

The Nuclear Radiation Laboratory houses the University's cyclotron. Although not widely publicized, some of the most fundamental and vital research has and is being conducted there. Cyclotrons have been known since their invention to be nearly as complicated and sensitive as women, but in the last few years many cyclotrons, including ours, have changed, and now work as any good physical instrument should work.

The basic problem underlying almost all of the experimental investigations is the structure of the atomic nucleus and the laws governing it. The beam of the cyclotron is especially suited to this work, with 6 Mev. protons, 12 Mev. deutrons, or 24 Mev. alpha particles available. Despite the fact that this branch of nuclear physics (the "classical nuclear physics") is much older than the high energy field, recent developments in instrumentation have opened up new possibilities for fundamental research.

The laboratory has its own well equipped machine shop, a large variety of electronic instruments, and equipment for nuclear emulsion and other photographic work.

Recently, a program supervised by Dr. P. G. Kruger and Dr. W. K. Jentschke consisting of precision elementary particle scattering has been successfully concluded with alpha-alpha and deutron-proton experiments.

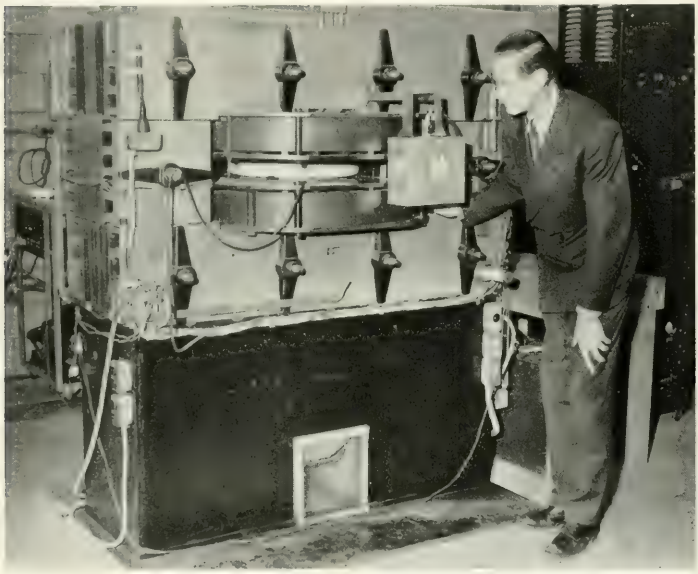
One of the main investigations headed by Dr. H. Frauenfelder at the present time is the directional correlation of nuclear radiations. The basic problem of these investigations is very simple: a nucleus emits in rapid succession two radiations, e.g., two gamma-rays. Does the second gamma-ray know in which direction the first has been emitted? Theory predicts that it does, and that the result of a measurement of the correlation between the two radiations can be used to gain information about important properties (quantum numbers) of the nucleus.

The first investigations were carried

out 5 or 6 years ago and the method developed into a standard measuring procedure. Two years ago, however, it was discovered that the nuclear angular correlation can strongly be influenced by external means, e.g., the field of the atomic shell or external magnetic fields. These effects are interesting because of the following reasons: (1) The influence of the electron shell and of the surroundings of the radioactive nucleus on the directional correlation introduces atomic and solid state physics into this part of nuclear physics. This coupling of different parts of physics makes the investigations more difficult, but it provides the possibility of attacking many interesting problems in atomic, nuclear, and solid state physics, which are very difficult to reach from other directions. (2) The fact that the directional correlation can in some cases be influenced by external magnetic fields allows the measurement of the magnetic moments of excited nuclear levels. This important property escaped formerly all methods.

A fascinating experiment which is now being done by Doctors J. S. Allen and W. K. Jentschke and others is an investigation of the role played by the neutrino in the decay of radioactive nuclei. The neutrino is a particle postulated by physicists to account for the energy loss in some nuclear transformations one of which is the beta ray decay of nuclei. The neutrino is supposed to carry no charge and to have a very small mass, hence it can pass unhindered through miles of matter. For this reason, no one has directly observed neutrinos experimentally.

At Illinois, the experimenters hope to establish the type of interaction responsible for beta ray decay. In general, the experiments require the determination of the form of the angular correlation between the directions of emission of the beta ray and recoiling nucleus. The beta rays are detected with a scintillation counter and the recoil nuclei are counted with a special electron multiplier tube. In order to obtain very thin sources, radioactive gases at low pressures have been used.



Professor D. W. Kerst, builder of the first successfully operating betatron, inspects the 20 mev betratron. (Photo courtesy of the Physics Research Laboratory)

SOLID STATE PHYSICS

The solid state physics research group at the University of Illinois is considered to be one of the finest such groups in the world. Heading the staff are Professors Bardeen (co-inventor of the point-contact transistor), Seitz, Koehler and Maurer. A discussion of some of the various phases of research follows.

Plastic Deformation of Crystals and the Radiation Damage of Solids. Dr. J. Koehler is presently working in the field of plastic flow in metals. This deformation research is interesting in that the experimental results are behind the theoretical work. The dislocation theory is very rich and for each phenomena observed there are usually several explanations offered. Hence, there are many critical experiments being conducted in the attempt to clear up the ambiguity.

The study of the imperfections produced in solids by fast particle irradiation has already provided new information of value to those interested in the solid state. For example, it has been demonstrated that these imperfections speed diffusion. The research program in this field at Illinois is aimed at obtaining a basic understanding of the production, the nature, and number of such defects, and of their behavior during annealing. The damage experiments done here thus far have already given information of value concerning diffusion, concerning the types of defects produced during cold-work, and concerning the influence of impurities on self diffusion. Thus, radiation damage studies constitute a powerful tool for solid state research. Dr. Overhauser is presently in charge of this experiment.

Semiconductors and Transistor Electronics. Semiconductor and transistor electronics research is being conducted in the Department of Electrical Engineering under the supervision of Dr. J. Bardeen. The general aim of the program is to learn more about fundamental properties of semiconductors, with emphasis on those which may be important for diodes and transistors. Present work is concerned with surface properties of germanium, an electrolytic analogue of a transistor, properties of fused junctions and internal friction and diffusion in germanium. Professor Murrell is directing a separate but related program on the semiconducting properties of lead telluride.

Low Temperature Research

The principal item of large equipment used here in connection with low temperature research is a Collins Helium Cryostat. This helium liquifier can produce about five liters of liquid helium per hour. Of course, facilities are available for storing liquid helium and transporting it to remote experimental stations.

Liquified helium boils under atmospheric pressure at a temperature of 4.2°K or -454°F. By pumping off vapor from the liquid helium, temperatures as low as 0.77°K have been obtained, though temperatures much lower than this may be obtained through other means.

Using liquid helium, investigations are being made of superconductivity. This is a phenomenon which occurs in some metals at very low temperatures. The most striking effect of this phenomenon is the sudden drop of electrical resistance of the metals at a certain temperature, which is different for each

A NEW RELAY RECORD

RELAYS—which are high-speed switches—are the nerve centers of the dial telephone system. In a split second, they set up a connection and then are off to direct the next call. In a large city, more than 1000 relays are used every time a number is dialed.

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superconductor. (For alloys as high as 15 to K. for pure metals around 8 K and lower). Below this transition temperature, the resistance drops to zero; at this point many very interesting and striking effects are observed. For example, one of the effects observed is the floating of a superconductor above a magnet without any mechanical support. This is explained by the fact that the superconductor will not allow any magnetic field to pass through, and the result is that the superconductor will "sit" on top of the magnetic field due to the magnet. However, the fundamentals of superconductivity are not well understood even after forty years of work.

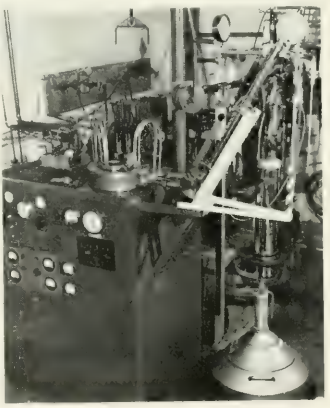
Outside the study on superconductivity, the properties of liquid helium itself are also being studied; for associated with liquid helium, there are many remarkable phenomena which can not be observed with any other liquid. When liquid helium is cooled below 2.19°K (the lambda point of liquid helium), a phase transformation of the normal helium occurs. The result is the formation of a new liquid phase (usually called Helium II). Helium II has properties that are strikingly different from the Helium I, the ordinary helium, or any other liquid. Of these properties Rollin film effect is one of the more remarkable. In this effect the liquid helium is observed to flow against gravity up the side into a container, when the container is lowered into a bath of liquid helium.

In another investigation, study is being made of the properties of matter at extremely low temperature (of the order of 0.01°K). In order to make such a study, some methods in addition to pumping off vapor from liquid helium must be employed. Here a method called "adiabatic demagnetization" is used. In this method a paramagnetic material (a material whose atoms behave like small magnets) is cooled to helium temperature by suspending it in a vacuum bottle and surrounding the bottle with liquid helium. Helium gas is allowed to pass in and out of the vacuum bottle to serve as a conductor of heat. A vacuum pump is used to obtain a temperature of about 1°K. After this an external magnetic field is applied to line up the "atomic magnets" of the material. During this process of magnetization, the material will heat up due to the forced orientation of the atomic magnets. The heat developed is absorbed by the surrounding helium, some of which is boiled off. Then the vacuum bottle is sealed, after the helium gas inside is pumped away. Next the external magnetic field is cut off. During this process of demagnetization—by cutting off the external magnetic field — the paramagnetic material will cool the whole volume inside the vacuum bottle. The resulting temperature may be as low as a few thousandths of a degree Kelvin. In this way the study of the properties of matter at these extremely low temperatures is made possible.

These are some of the research projects in the field of low temperature physics; of course, several other projects are being conducted in conjunction with other groups both in and out of the physics department.

Biophysics and Photosynthesis

A number of biophysical investigations centered about the interaction of light with biological systems are being carried out in the physics department by Dr. Rawcliffe and in the photosynthesis laboratory of the Botany Department by Dr. Emerson and Dr. Rabinowitch. Among these are the following: (1) The absorption of light, as in photosynthesis starts a chain of reactions and various intermediates are formed in rapid succession. The rapid changes in the absorption spectra which occur are being studied to find information which will help unravel these processes. (2) Many of the key chemical constituents of cells are concentrated in definite locations within the cell. If the chemicals at the various locations can be identified valuable clues will be provided to the function of these chemicals in the cell. A micro-spectrophotometer is nearly completed. It will be used principally for the above chemical identification. It is expected to be useful also in the study of the interactions of molecules in microcrystals, etc., discussed under (4). (3) The efficiency with which a plant converts light energy into chemical energy, i.e., the quantum yield of photosynthesis is of great importance both because of its practical aspect and because it can provide information essential to the formulation of any theory of the photosynthetic process. A rather violent controversy exists regarding the true value of the quantum yield. Measurements are being made here in an effort to tie down unequivocally this vital quantity. (4) When colored molecules are closely packed as in crystals or as in pigment centers in plants, interesting interactions occur which are important in photochemical reactions such as photosynthesis since they lead to exchange and migration of excitation energy. The changes in the absorption, fluorescence and light scattering are being studied as molecules condense into microcrystals and monolayers, in order to obtain a better understanding of these intermolecular interactions.



Apparatus in the Physics Laboratory used to generate liquid helium. (Photo by Bob Feldman)

Electrode Physics

This project, headed by Dr. J. H. Bartlett, is concerned with the changes which can occur on or near an electrode immersed in a solution. One of the experiments dealt with a copper anode in an HCl solution. The experimenters found that a solid layer formed on this electrode, and that concentration changes occurred in the solution immediately adjacent (within .05 cm) to the electrode. They took microphotographs of the electrode and now know how the layer grew. They also devised optical methods for studying the variation of the index of refraction of the solution, both as a function of space and of time.

Their present task is to integrate all the data that they have, both electrical and optical, into one consistent picture and to test this picture in general. Such a picture will be of enormous value in clearing up the mechanisms of rectification, electropolishing, passivity, periodic current oscillations, corrosion, and even of such a seemingly unrelated process as the conduction of an impulse along a nerve.

Helium Wave Equation

This project, also headed by Dr. J. H. Bartlett, has as its problem the finding of a solution, accurate to about one part in 100,000, of the wave equation of the helium atom. This is desired both for the ground state and the first excited state. When done, it will provide (1) the first accurate solution of a many-body problem, and (2) information about the He^3 nucleus, the magnetic moment of which has been measured.

Before this investigation was started, there were no successful attempts to find a wave function for helium. However, the problem is now being coded for the Illinois digital computer. When the present approximation has been run on the machine, the results will be analyzed with the aim of developing still more powerful and precise methods.

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CIVIL ENGINEERING RESEARCH

by the Research Staff—Civil Engineering Department

Structural research here at the University of Illinois involves work in the laboratory, theoretical studies, and computations. To get any idea of the work going on in structural research, all one has to do is see the massive machines of Talbot Lab in action. Here tests are continually being run on steel and concrete members.

One long range project is the tests being made on pre-stressed concrete. Beams are made of concrete, which is high in compressive strength but low in tensile strength, with high strength steel rods added which are under a high tension. Load stresses on the beam will then be canceled by the pre-stresses in the rods. Such beams show little signs of cracking while under working loads.

These beams as any other beam can fail in either of two ways. There can be a failure in flexure or in shear. In the first case the beam fails either under tension in the lower half where it would pull apart, or it fails in compression above the neutral axis where it would crumble. In the second case the beam will shear or break apart vertically.

The purpose of testing these beams that is now being carried on is to find the ultimate load that the beams will carry. The concrete, number of rods and pre-stress in the rods are varied. The loads that will cause failure in flexure and those that will cause shear are both determined.

From these ultimate loads a safety code is made. In practice the beams are made to fail in flexure rather than in shear. The reason for this, that cracking will precede a failure in flexure, while a shear failure gives no warning.

A project for testing reinforced concrete eccentric loaded columns is also being carried on. An eccentric loaded column is a member that has a load applied to it at a point that is not on the axis of the column. Such a column contains a bending stress. It is surprising that 99% of all columns are eccentrically loaded, yet the present codes for such columns are based on judgment rather than facts. It is for this reason that tests on eccentrically loaded columns are now being run.

The tests are divided into static tests and continuous loading tests. In the first, the stresses are increased until the ultimate loads are reached. In the second a constant load is applied for a long period of time. Under such a condition the concrete will tend to "creep."

Fatigue in plain concrete is also a research project under way. Four-foot beams of various strength concrete have a repeated load applied to them until they fail. These tests show that the limiting load that can be repeated a certain number of times will be the same percentage of the maximum load, regardless of the concrete strength. It is also shown that a sufficiently small load may be repeated indefinitely without causing failure.

The fatigue of steel columns in compression is another project in structures research. The compression on small steel columns is repeatedly varied from 500 to 30,000 pounds per square inch until they fail. From these tests the fatigue in full-sized columns can be determined.

A long-time project that has been carried on in connection with the railroads is the study of fatigue in rails. This is a full scale project with huge wheels being passed back and forth over various sizes of rails.

Other projects in structural research are being carried on to find the ultimate loads of riveted and welded joints, the fatigue in these joints, ultimate loads of copper connections, stresses in knee braces and fatigue in concrete slabs.

All of the research of the structural stresses consists of tests on simple structural elements. These results are then used to calculate the stresses in the larger structures of the field.

Hydraulic Engineering Research

The Civil Engineering Department has well-developed facilities for research in Hydrology and Hydraulic Engineering. Present programs include both laboratory and analytical studies. Laboratory investigations are accomplished through model studies and analysis of data derived from model tests. A program on highway drainage is now nearing completion. With the cooperation of the Illinois Division of Highways and the U.S. Bureau of Public Roads certain phases of drainage problems related to super-highways or expressways were studied with a view to study the special problems which arise in connection with this type of highway.

Some expressways are depressed below the level of the surrounding terrain. All of the precipitation is therefore trapped in a long and very narrow excavation. The problem is further complicated by the fact that in order to reduce excavation costs the roadway grade is kept at a higher elevation between street crossings and lowered to provide the necessary vertical clearance under bridges. This gives a sort of roller coaster effect to the finished roadway. In addition, sloping ramps are required to provide access to the expressway at certain designated points. The very nature of the purpose of an expressway requires that probable traffic interruptions due to flooding must be kept at a minimum so that adequate drainage facilities must be provided. The problem involves determination of: gutter capacity; provision of efficient grate sections capable of intercepting the volume of water, determined by the inlet spacing; size of inlet boxes or catch basins and drains to carry the water from the inlets to the main drain. Since the cost of an expressway drainage system is necessarily quite high, research activities can be justified because they reveal ways and means by which costs can be reduced. Highway

What's Happening at CRUCIBLE

about hollow tool steel

Crucible is now making its high quality tool steel available in hollow form. Bars of Crucible Hollow Tool Steel can now be obtained with machine finished inside and outside diameters and faces — in three famous grades: KETOS, AIRDI 150 and SANDERSON. Already its use has effected substantial savings for makers of tool steel parts with cutout centers.

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3¼ O.D. x 1¼ I.D.	x	x	x
3¼ O.D. x 1½ I.D.		x	
3½ O.D. x 1½ I.D.	x		
3½ O.D. x 2 I.D.	x	x	x
4 O.D. x 1½ I.D.			x
4 O.D. x 2 I.D.		x	x
4¼ O.D. x 1¾ I.D.			x
4½ O.D. x 2 I.D.	x		x
5 O.D. x 2 I.D.	x	x	x
5 O.D. x 2½ I.D.		x	x
5 O.D. x 3 I.D.	x	x	
5½ O.D. x 1¾ I.D.			x
5½ O.D. x 2 I.D.		x	
5½ O.D. x 2½ I.D.	x		x
6 O.D. x 1¾ I.D.			x
6 O.D. x 2 I.D.		x	
6 O.D. x 3 I.D.	x	x	■
6½ O.D. x 3¼ I.D.			■
6½ O.D. x 3½ I.D.		x	
6½ O.D. x 4 I.D.			■
7 O.D. x 2¼ I.D.			x
7 O.D. x 3 I.D.	x	x	
7 O.D. x 3½ I.D.			x
7 O.D. x 4 I.D.	x	x	
7½ O.D. x 3 I.D.	x	x	
7½ O.D. x 3½ I.D.	x	x	
7½ O.D. x 4 I.D.			x
8 O.D. x 3½ I.D.	x	x	
8 O.D. x 5 I.D.	x	x	■
8¼ O.D. x 3½ I.D.			x
8½ O.D. x 5¼ I.D.	x	x	x
9 O.D. x 4 I.D.	x	x	
9 O.D. x 5 I.D.		■	■
9 O.D. x 6 I.D.	x		
10 O.D. x 4 I.D.		x	
10 O.D. x 5 I.D.	x	x	
10 O.D. x 6 I.D.	x	x	x
11 O.D. x 4 I.D.	x	x	
11 O.D. x 6 O.D.	x	x	
11 O.D. x 7 I.D.		x	x
12 O.D. x 5 I.D.	x	■	x
12 O.D. x 6 I.D.	x	x	
12 O.D. x 7 I.D.	x	x	
12 O.D. x 8 I.D.		x	
13 O.D. x 6 I.D.		■	x
13 O.D. x 7 I.D.	x	x	
13 O.D. x 8 I.D.			x
13 O.D. x 9 I.D.		x	
14 O.D. x 7 I.D.	x	x	x
14 O D x 10 I D.		x	
15 O.D. x 9 I.D.		x	x
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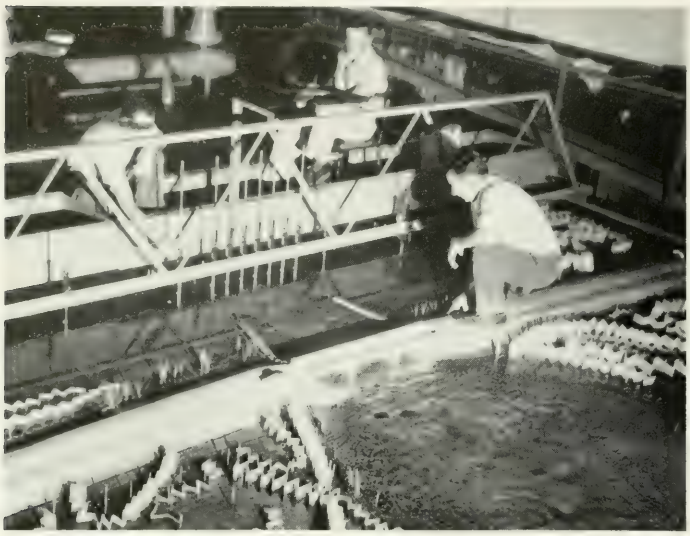
drainage practice in the past has been more or less traditional and engineers have come to realize that what may have been satisfactory in the "horse and buggy days" is not suitable or economical for modern traffic.

A second research problem which is of a purely analytical nature deals with "Frequency Analysis of Hydrologic Data." This study includes an analysis of rainfall amounts, intensity or rate of fall in inches per 5 minutes, 10 minutes, etc., and recurrence interval, 2 years, 5 years, etc., up to 50 years. Results of this study are usable in other investigations. A University of Illinois Experiment Station Bulletin reporting the results of this project is now in press.

A third problem concerns the "Hydraulics of Flow at Bridges." This study consists of determining the effect of flood flows around bridge piers and abutments for the purpose of avoiding erosion of the earth channel above, under and below the bridge. A model study of an overflow bridge on the flood plain of the Wabash River in Illinois was completed recently. This study was undertaken to detect methods of correcting an existing dangerous condition. Other specific bridges are now under study and it is expected that design criteria will be developed for use in connection with proposed new bridges.

Another current research investigation deals with the "Determination of Waterway Areas" for bridges and culverts for highways. This problem involves both hydrologic and hydraulic analysis which will develop a simple but scientific solution of a problem which heretofore has received relatively little attention when its importance to the economy of construction costs and safety of operation are considered.

A number of other research projects dealing with urban drainage, agricultural drainage, flood routing and water power development are being carried on for purposes of development of engineering science and to contribute toward better teaching of undergraduate and graduate courses in the hydraulic field of Civil Engineering.



Model of Illinois Highway 460 bridge over Wabash River flood plain, built to study eddy which threatened to drop the bridge into a 40-ft. deep hole.

Research in Sanitary Engineering

"The Thing" in the well-known popular ditty was a box containing a valuable substance or article which nobody wanted, which was a hazard to its possessor, and which he could neither dispose of nor destroy. Undoubtedly "The Thing" was radioactive material. We all share possession of "The Thing," it is becoming more and more extensively used in medicine, in the arts, and in industry, and we are now faced with the problem of disposing of it after use. The Atomic Energy Commission is devoting attention to this problem, studies being made at Oak Ridge, Los Alamos, New Mexico, and other places under the immediate control of the A.E.C. and at the engineering experiment stations of various universities.

The University of Illinois has been assigned the project of studying the effect of radioactive materials on the septic (anaerobic) digestion of sludge and the degree of concentration of radioactivity by sludge digestion. Radioactivity is indestructible other than through the ultimate exhaustion of fissionable elements. Some substances become essentially exhausted in a fraction of a second. Others may endure for a century or more. The disposal of such long-life substances in sewers creates the problem being studied here.

The Sanitary Engineering Laboratory is equipped for such studies since it is conveniently located to draw its supply of sewage from the main outfall sewer of the Urbana-Champaign Sanitary District. Tanks are provided for the accumulation of sludge and the laboratory equipment includes a room held constantly at a temperature of 92° F. in which the digesters are housed. Chemical and biological laboratories are available for routine tests and a special shielded laboratory and a special counting room are provided for the handling of the radioactive materials by the personnel trained for this purpose.

Water for troops in the field is a military problem of importance upon which has depended the success of some historic campaigns. The filtration of water by conventional rapid sand filters requires the establishment of permanent installations which cannot be moved and involve serious problems for the transportation of chemicals required in operation. During World War II a filter was developed and used in the Japanese, German, English, and American armies which was relatively mobile in the sizes required by troops in the field, and was advantageous in fixed locations because of the relatively small amout of material to be trnsported. This filter, known as the diatomite water filter, has been under investigation in the Sanitary Engineering Laboratory for more than five years under a cooperative contract with the Engineer Research and Development Laboratory of the U.S. Army at Fort Belvoir, Virginia. During this period the efficiency of operation and the equipment to be used have been improved. Studies at present are being directed toward an improvement of the treatment of water before passing it on to the filters. The polluted water from the Boneyard has provided a most desirable source of water on which to test the filters. The wide and rapid variation in quality of this flashy stream puts an excessive stress on the test filters beyond the limits to be expected normally in the field.

Copper tubing for wastes pipes in household plumbing may result in reduced construction costs provided the useful life of the copper in contact with sewage will equal or exceed that of the

commonly used cast-iron pipe. A joint study in cooperation with the Copper and Brass Research Association has been in progress for seven years and is now approaching a conclusion. Three copper tube soil stacks and one vent pipe have been set up in the Laboratory through which sewage from the local outfall sewer has been pumped under controlled conditions for the period of the investigation. Corrosion has been measured by observing loss of weight of the pipes; increase in electrical resistance; and measurement and observation of pitting and incrustation.

Problems in plumbing involve questions of hydraulics and pneumatics that are solved today by trial and error and practical experience. Such solutions are successful but that they are also economical is open to doubt. Tests to answer some of these questions were conducted for a year under a cooperative agreement with the Federal Housing and Home Finance Agency. Although no active research in this field is now in progress, the equipment, equal to the complete plumbing for a three-story residence, is still in place in the Laboratory, together with much supplemental apparatus and equipment in anticipation of a resumption of the studies in the near future.

How to build a household septic tank is a question frequently asked by correspondents with the Engineering Experiment Station. In order to answer this question more intelligently a cooperative agreement for the study of metal tanks was entered into with the American Rolling Mills in Ohio. The contract was completed in 1951 and a bulletin based on these studies is in preparation by the Engineering Experiment Station. Five of the six septic tanks studied are in place under the lawn alongside of the Sanitary Engineering Laboratory, ready for an extension of the studies at any time.

Soil Mechanics

Soil mechanics is a relatively new branch of civil engineering. Only in the last 30 years has science provided methods for determining the physical properties of soils and other foundation materials, for computing the settlement of structures, or for estimating the degree of stability of natural slopes, embankments, or earth dams.

At present, the most important research in this field is the evaluation of the reliability of the scientific methods when applied to actual conditions, and the development of techniques for the application of scientific principles to the practical work the engineer must accomplish. Hence, research in soil mechanics at the University of Illinois emphasizes field observations of the actual behavior of foundations, slopes, tunnels and earth dams during and after construction. The results of the observations are correlated with predictions based on theory and laboratory tests.

One research project, in cooperation with the Association of American Railroads, studies the causes and cures of unstable railroad subgrades throughout the United States and Canada.

A second project deals with the movements of retaining walls and abutments on clay soils. In connection with the Illinois Division of Highways, systematic measurements of movements and soil tests are made on all suitable new bridge construction in the state, and methods are being developed for better design.

Particular attention is given to methods of designing foundations for industrial structures, large and small. Studies of the foundation problems unique for each locality with a different geological setting are being made and assembled into a sort of foundation atlas for the United States. This is a long-range project that will require many years.

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How to lick dust, moisture and acid fog

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Agricultural Engineering

by Howard Hadler, Ag. E., '54

The Agricultural Engineering Department at the University of Illinois carries on an extensive research program in order to develop new farm equipment and farm practices and to improve existing equipment and practices. The research program covers such a scope as to allow several members of the staff to devote full time to it. Also the agricultural engineering research program is characterized by extensive cooperation with other agencies. At the present time three industrial or commercial organizations contribute to full-time projects. The Aluminum Company of America contributes to a research study for the purpose of determining the ways in which aluminum can be used in farm structures and building equipment. The Illinois Agricultural Association, and Country Mutual Fire Insurance Company sponsors a project aimed to find and eliminate the hazards that cause fire and wind losses. The Public Service Company of Northern Illinois and its affiliates sponsor studies in the applications of electricity for farm operations. Along with these companies many others provide aid for agricultural engineering research projects.

At the end of World War II, the capacity for productiion of aluminum led to the search for new uses. The qualities of light weight, resistance to corrosion, relatively high strength, and workability, together with the potential supply gave indications that aluminum might be widely used.

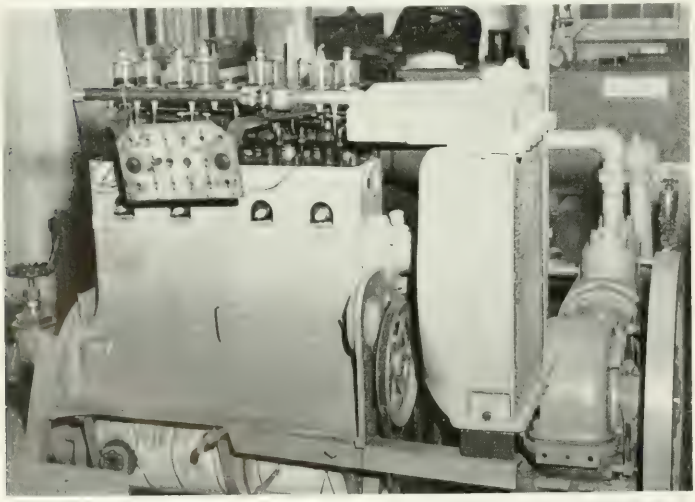
On the other hand, aluminum was not resistant to corrosion under certain conditions, little was known as to requirements of gages, shapes, and methods of application for farm uses. Prevailing building plans had not been prepared with aluminum in mind. The research programs in conjunction with the Aluminum Company of America have been carried on to develop new building planes, to study the application of sheet materials, analyze the results of using aluminum for a variety of purposes — gates, windows, dairy stalls, poultry equipment, and other devices; and to study such problems as nailing, handling, reflective qualities, durability in paints, and possible deficiencies under various conditions.

The principle work under this project includes: (1) Construction of an experimental poultry house, and accumulation of data, (2) Use of aluminum foil, reflective insulation and sheets, (3) Study of methods of application for sheets of various thicknesses, (4) Tests of aluminum devices and equipment in use, and (5) Development of building plans for best utilization of aluminum sheets.

In another project, sponsored by the Illinois Agricultural Association, and Country Mutual Fire Insurance Company, it is found that in the final analysis, the safeguards against loss not only reduce the cost of insurance, but prevent inconvenience, damage, injury, and possible loss of life. Evidence gathered from various sources reveals that a few major preventative measures may reduce losses by millions of dollars. For example, safe wiring, safe flues, lightning protection, and recommended practices in the installation and use of heating systems and fuels might prevent a majority of farm fires. Building repair, anchors, bracing, use of suitable materials, and recommended construction methods prevent major windstorm losses.

This research program is directed toward: (1) Analysis of records of loss, (2) Development of methods to offset losses, (3) Assembly of recommendations for loss prevention, (4) Organization of training and demonstration programs (5) Preparation of practical inspection form, and (6) Publication of recommendations.

A project sponsored by the Public Service Company of Northern Illinois and its affiliates is studying the opportunities for greater use of electricity. Illinois farms are more than 90 per cent electrified, but opportunities are present for far greater use of electricity. In the past, electricity has been used for lights, home appliances, cooking and refrigeration, and to a lesser extent for dairy



Part of the experimental equipment used in the research on valve wear. Various lubricants are used to determine their effect on valve wear.

work, feed grinding and miscellaneous jobs.

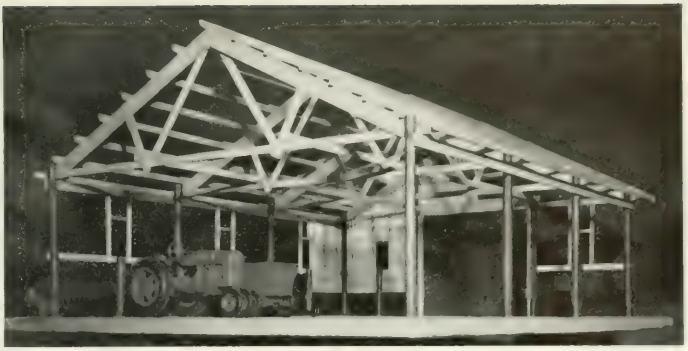
The future expansion of electric service depends largely on the development of automatic processes, new devices, and machines for work at the farmstead, and on new methods of operation. Electricity can serve especially well in the field of processing for such purposes and feed grinding and mixing, feed and silage handling, crop drying, and refrigeration. Electric power is needed for operating feed distributors, ventilating fans, barn cleaners, and heater controls. Heat lamps, tank heaters, animal and chick brooders, and heating cable are examples of electrical applications that need study.

The present work on electric application is centered on two major studies, with much more to be done later: automatic feed handling, grinding, mixing, and distribution; and control of environment by ventilation and supplemental heat.

Since 1948 three cooperating organizations have been active in the development of automatic feed-handling equipment at the Illinois Agricultural Experiment Station, Urbana, Illinois: (1) the Public Service Company of Northern Illinois; (2) the Agricultural Engineering Department, University of Illinois; and (3) the Farm Electrification Division, U. S. Department of Agriculture. During this period processes and equipment have been developed to move ear corn from a crib or storage bin into an auger-type feeder for a hammermill; blend and mix shelled corn, oats, and concentrates and feed such mixtures into the hammermill; and control the operations of this assembly by an electrical control box.

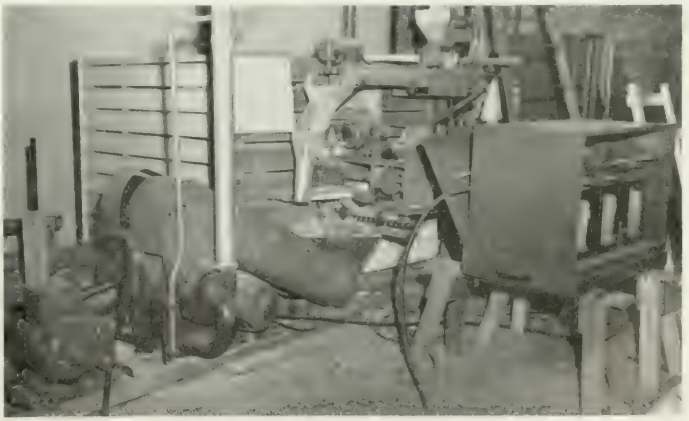
Another project is the investigation of protective coatings for weathered galvanized sheets. Galvanized metal sheets are extensively used for siding and roofing of farm buildings. Weathering deteriorates the zinc coating on these sheets and exposes the metal sheet to rust action, presenting a common maintenance problem. Protective painting may be used to prevent rusting. However, many considerations are involved, such as determining the proper kind of paint to use, deciding on the proper time to repaint, and finding the best method of application.

In 1932, the American Zinc Institute began conducting tests on the value of various paints as protective coverings for galvanized sheets. Test panels were coated with different paints and the resistance to weathering was noted. In 1948, the records for the sixteen years were turned over to the Department of Agricultural Engineering. By this time test panels covered the entire roof area of six buildings on the farm of Raymond Harwood at Donnellson, Illinois. In all, 91 paints were used in the study, including all coatings that were regarded as suitable for use or which had been commonly used on galvanized metal. The Department of Agricultural Engineering and the Agricultural Experiment Station was to analyze and interpret the records and report conclusions as to the kind, or kinds, of paint to use, how the paint should be applied, and how the paint coatings compared in relative durability under typical farm conditions. Also, in 1948, a new series of tests was begun at the Illinois Agricultural Experiment Station to include a wide range of old and new products in various coatings and combinations. This new series of tests which is now being carried on provides for ample checks, duplications, and uniform exposure conditions. The data which was collected prior to 1948 has been analyzed and interpreted and has been prepared for publication in a bulletin on the "Durability of Paints on Weathered Galvanized Roofing," Bulletin 565 of the University of Illinois Agricultural Experiment Station.



A model of a pole-frame machinery storage building showing the basic construction features.

Much time is being devoted to the study of farm buildings. The Department of Agricultural Engineering cooperates with the Small Homes Council of the University of Illinois and with the North Central Region, comprised of Agricultural Experiment Stations of various colleges and universities in the north-central region of the United States, in its studies of farm buildings. One of the major problems in livestock housing and crop and machine storage is in keeping the housing facilities functional while introducing the necessary changes due to advancement in farm practices. Necessary design changes must be continually developed. Added knowledge and new advancements in construction principles also necessitate a continuing change in design.



Automatic feed-grinding equipment which is being developed and tested by the Department of Agricultural Engineering in cooperation with other agencies.

The research in farm building design comprises many separate projects, the results of which are used to develop new designs and new design and construction principles. As one phase of this research work, a basic farm house plan has been developed which can be altered in innumerable ways to suit the needs of the individual. Another result of the farm housing research is the "flexi-plan" which consists of a basic plan for the living unit with a number of supplemental plans which may be added to the basic plan to provide a one, two, or three-bedroom house, or to provide a different type of room arrangement outside of the basic unit.

Other research is being carried on to improve the arrangement and design of livestock housing units with special emphasis given to the efficient use of farm labor. Also construction principles are being studied to determine various ways of constructing farm buildings with emphasis placed on availability of materials, and practical and economical construction.

Studies are being carried on on tractor valve troubles. In the past operators have been confronted with valve troubles in tractors such as excessive valve wear and valve sticking. The tests on the causes and cures of tractor valve troubles has been going on in the department for some time now and has been recently expanded to include a total number of sixty tractors. This increase was made possible by a contract between the Department of Agricultural Engineering and the Northern Regional Research Laboratory of the U. S. D. A. at Peoria, Illinois. The cause of some of the troubles has been found to be due to lead and gum in the fuels used, lubricating oil quality and engine design. The new studies has been devised to try to find out the relative importance of the various causes and to try out some of the remedies suggested. The division of the tractors in the test is to be made as follows: twenty farm tractors in the Champaign-Urbana area will operate on "white-gasoline" with alcohol-water injection devices to prevent knocking caused by the white gas; twenty tractors with the usual valves and fuels will be used as a check; ten tractors will be equipped with exhaust valve rotators along with ten others which already are running under test conditions. Along with these, a test unit has been set up in the research laboratory to determine the value of various lubricants in preventing valve wear and the extent of valve damage incurred during the use of these lubricants.

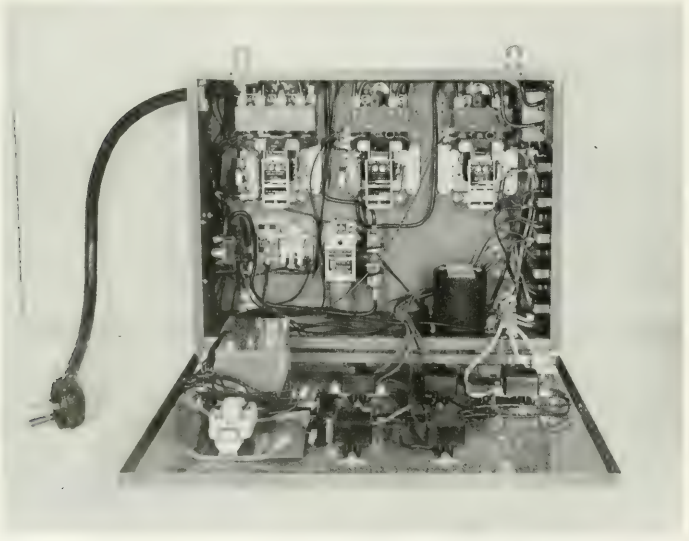
Experiments are being conducted to determine maximum efficiency of corn pickers. It is known that unless a corn picker is properly adjusted, much waste and loss of grain occurs. Some of the factors under consideration in this study are: proper setting of the snapping rolls from the ground; speed of the machine thru the field; and setting of the husking rolls along with other things. Another feature of this experiment is the application of the combine to the harvesting of corn. The combine is fitted with the cylinder and concave system as ordinarily except that the cylinder can be set at various angles, has a variable speed control on the cylinder, and there are six additional rasp bars on the cylinder to do a more complete job of cleaning the corn. Studies on this arrangement so far have shown a loss of only 1% of kernel corn and a loss of 4% due to damaged kernels. The chief hindrance to this project is the shortness of the season in the field and, therefore, the short amount of time that practical experimental work in the field can be done.

A project is also being carried on with connection to runoff from agricultural watersheds. Runoff rates and other data is being gathered on a portion of the Robert Allerton Estate near Monticello, Illinois. This data, along with other data on slope, vegetation and other factors can be used to develop soil-conserving practices.

One of the most important developments in the agricultural engineering research program has been the construction of the Agricultural Engineering Research Laboratory, which was completed in 1952. Before that time, the increased research program, along with other space needs, had resulted in crowding all phases of the department's program. The new laboratory, therefore, provided a much needed facility for the research work in the department. The building is single story of brick and concrete block construction with flat roof. Nearly 9,000 square feet of work space are provided by the building. The building provides for the needs of the research programs in structures, rural electrification, soil and water engineering, power and machinery and crop processing.

Along with the research facilities provided by the Agricultural Engineering Building and the Agricultural Engineering Research Laboratory, the Department of Agricultural Engineering operates a 40-acre farm on the University of Illinois farms at Urbana, Illinois and carries on experiments at the Robert Allerton Estate and the Dixon Springs Experiment Station. Also, many phases of the experimental work is carried on on various farms throughout the state of Illinois.

Besides the experimental work mentioned previously in the article, many other experiments are being carried on, which range from long-time studies of improvement in tillage practices, rust preventatives, and soil conservation methods, to graduate studies on limited projects. The results of the experimental work in the department is reported in bulletins and circulars of the University of Illinois Agricultural Experiment Station, and in articles in the Journal of Agricultural Engineering.



An electrical control unit developed by the department and used with the automatic feed-grinding equipment. In the picture it is opened for inspection.

METAL CUTTING RESEARCH

by Eric Aagaard, M.E., '53

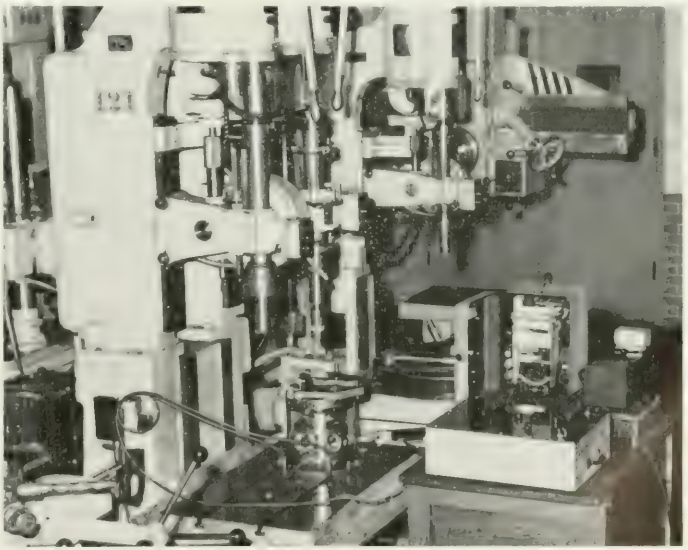
One of the many experimental investigations being carried on at the University of Illinois involves a long term study of the basic processes of metal cutting, by Prof. K. J. Trigger, Prof. B. T. Chao, Mr. B. F. Turkovich, and others of the department of mechanical engineering. Many of the problems in metal cutting involve obtaining maximum cutting speeds and efficiencies together with long tool life. Toward solving the problems, interesting test setups have been developed at the University of Illinois to study the variables involved, and to varify analytical evaluations of the problems.

Although most of the experimental work is being done on an ordinary 16x54-inch metal cutting lathe, the results obtained are equally applicable to other machines using similar cutting tools such as shapers, planers, milling machines, boring mills, etc. The tool-chip interface temperature has long been recognized as a limiting factor in metal cutting, because excessive temperatures will reduce tool hardness and life. The term, tool-chip interface, is used in preference to the term, tool-workpiece interface; because the area of mutual contact is between the tool and the chip coming off the workpiece, not between the tool and the workpiece. Temperatures are measured by using the tool-chip interface as the hot junction of a thermocouple circuit. It would be well to review some basic knowledge of thermoelectricity, before a further discussion of the Herbert-Gottwein tool-work thermocouple is made.

At a junction of two dissimilar metals an electric potential will be produced which varies in a direct relation with the temperature of the junction. A continuous electrical circuit made of two wires, one composed of each dissimilar metal, will contain two junctions of the dissimilar metals. The total electromotive force produced in the circuit will be the algebraic difference of the potentials produced at each junction. A current will flow in the circuit when one junction is held at a higher temperature than the second. These junctions are called the hot and the cold junctions according to their relative temperatures.

A thermoelectric circuit may be cut at any point and a wire of any conducting material may be introduced in the circuit without altering the electromotive force produced, providing that the two new junctions are kept at a common temperature. This law of intermediate metals allows the insertion of a potentiometer to measure the electromotive force produced by the difference in potential of the hot and cold junctions. In the usual circuit the hot junction is at the unknown temperature to be measured, while the cold junction is at the reference temperature. The circuit is usually separated at the reference junction for the insertion of the leads to the potentiometer, care being taken that both parts of the separated junction are at the same temperature.

The cutting tools used in these investigations are of a conventional design with inserted cemented carbide cutting edges. The carbide edge, together with the chip coming off the workpiece, serves as the hot junction of the thermoelectric circuit. Through a hole drilled in the shank of the tool, a carbide rod is placed in contact with the insert, but insulated from the shank. The carbide rod must be of the same chemical com-

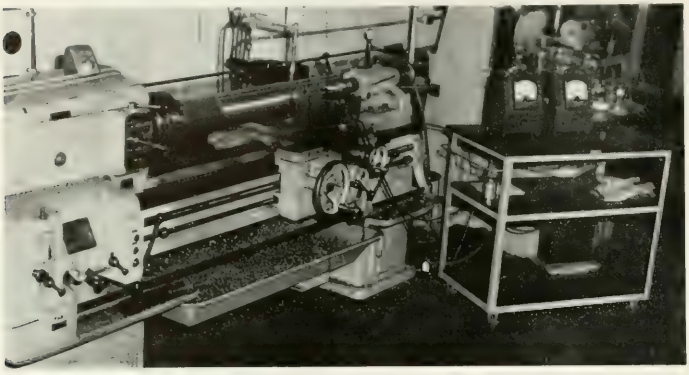


Drill press equipped to measure torque developed in tapping metals.

position as the cutting edge, otherwise a potential will exist at the point of contact between the two. The entire tool is insulated from the rest of the lathe. The free end of the carbide rod protruding from the end of the tool is connected by an iron lead wire to one terminal of a potentiometer.

An iron lead from the other terminal of the potentiometer is connected to a brush in contact with the rotating workpiece. This brush, insulated from the rake angle, workpiece hardness, and chip thickness.

For some analytical research it is desirable to know the cutting forces exerted on the tool. A unique dynamometer, designed and constructed in the department of mechanical engineering at the University of Illinois measures the vertical and horizontal components of the cutting force. When mounted on the test lathe, the horizontal component of the force is parallel to the axis of the



Measurement of metal cutting force with a toolholder dynamometer. (Photos by Bob Feldman)

frame of the lathe, is made from a section of the workpiece. By applying the law of intermediate metals, it becomes evident that the reference junction is jointly the connections of the potentiometer lead wires with the carbide rod and with the brush. Both these connections must be at the same room temperature. Calibration of a thermocouple, made from the same carbide and steel as used in the tool and in the workpiece, is done in an electric furnace using a standard chromel-alumel thermocouple to obtain the actual temperatures.

The potential produced by the tool-work thermocouple might be effected by several factors: the effect of chip force on the tool face, the effect of chip deformation, and the effect of friction due to the rubbing of steel on carbide. Various test setups were built to show that these factors had a negligible effect on the potential developed by the thermocouple. A discussion of these tests, together with a more complete description of the tool-work thermocouple may be found in the *Transactions of the American Society of Mechanical Engineers* for February, 1948.

The results of the numerous tests are too voluminous to be discussed in this article. Much valuable data has been obtained as to the effect on interface temperature of such variables as cutting surface speed, tool feed rate, tool back-

rotating workpiece while the vertical component is tangential to the rotating motion of the workpiece. The cutting tool is mounted in a holder at the end of a stiff, short cantilever arm of rectangular cross-section having approximately 0.0008 inch deflection under a vertical load of 600 pounds. The minute deflections caused by the components of the force are measured by two electric gage heads, one each mounted to act in the vertical and horizontal directions. The operation of the electric gage head involves the unbalancing of a reactance bridge circuit, by changes in the air gap of an iron core reactor as produced by the deflecting cantilever. The tool holder was designed so that both components of the cutting force act approximately through the longitudinal centroidal axis of the cantilever. Thus the arm will deflect only in the direction of the force acting upon it. The device is calibrated with dead weights. Using the results of such dynamometer tests, an analytical determination of interface temperature may be developed based on the theory of metal cutting. The calculated values of interface temperature thus obtained are in fair agreement with those determined with the tool-work thermocouple.

Part of the current work in the tool cutting research program involves a study of tool wear caused by diffusion of metal from the workpiece into the carbide insert of the cutting tool. Diffusin in the tool will be detected using an X-ray technique.

Another current investigation involves a study of the torque developed in metal tapping. The forces developed by the tap cause strain in the specially designed fixture which holds the workpiece. Wire strain gauges, each consisting of a network of fine wire, are firmly cemented to the fixture. Changes in the electrical resistance of the network, caused by strain in the fixture, are measured with a sensitive resistance bridge circuit. Since the strain produced in the fixture depends on the forces exerted by the tap, calibrated wire strain gauges provide a simple method of measuring these forces.

The old jalopy puffed up to a rattling halt at the toll bridge.

"Sixty-five cents," said the bridge-keeper.

"Sold!" cried the driver.

* * *

First salesman: Jack, you are only eating crackers and milk. Are you on a diet?

Second: No, commission.

* * *

"You're a young man with both feet on the ground, eh? What do you do for a living?

"I take orders from the guy with both feet on the desk."

* * *

Housewife: Mable, what happened to the canary?

Maid: I can't imagine, mum. It was there when I cleaned out the cage with the vacuum cleaner.

* * *

Prospective tenant: But why do they make these apartments so small?

Agent: That's so the tenants will have no room for complaint.

* * *

Money talks is a common expression —but no one ever hears his departing cash say "I'll be back soon."

Crossword Answer

D	A	M	■	A	C	U	T	E	■	A	D	A	M
A	R	E	■	B	U	N	A	S	■	L	A	V	A
F	E	N	S	■	G	I	N	■	S	E	T	O	N
T	A	■	T	H	A	T	■	S	P	R	A	G	■
■	■	S	E	A	T	■	S	L	I	T	■	A	N
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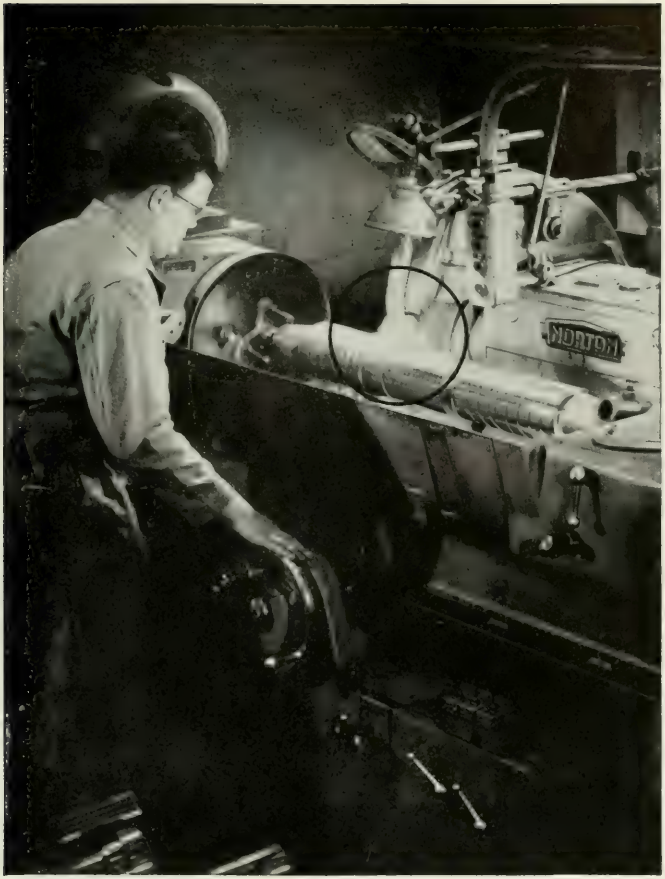
W	O	N	T	■	A	D	O	R	N	■	A	G	E
O	N	E	S	■	S	A	T	Y	R	■	N	E	W

(Puzzle on page 60)



The New Norton G Bond. The grinding wheel this man is using — in a Norton grinding machine — is made with the new Norton G Bond, one of the most important grinding wheel achievements in 45 years. The G Bond is a special vitrified bond, developed by Norton research engineers, that gives greatly improved grinding performance in many precision and semi-precision jobs — typical of the "Touch of Gold" that Norton brings to *all* grinding.

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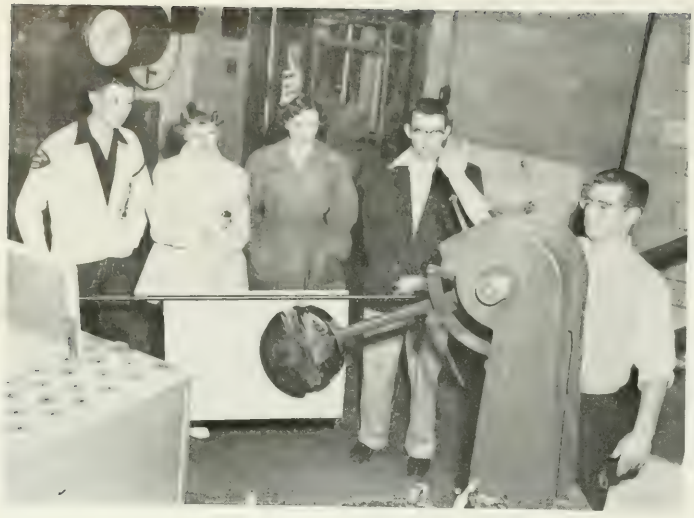
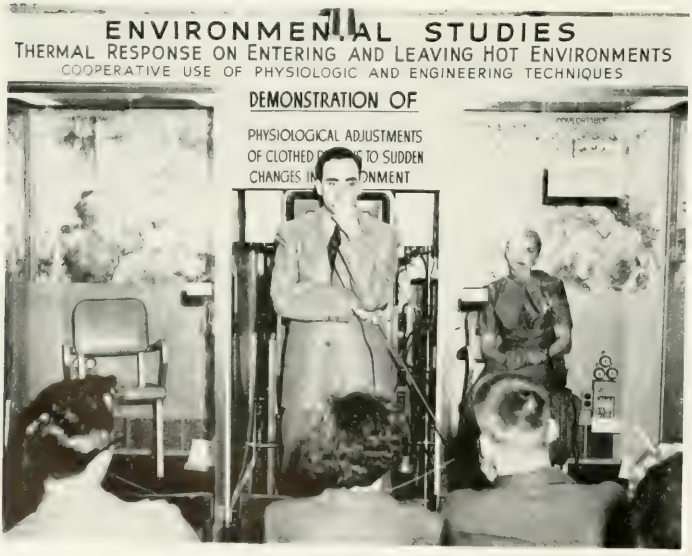


Above: Testing of metals with a Charpy impact machine in the Metallurgy Laboratory. Below: An interesting exhibit in the M. E. Laboratory of the effects of air conditioning on the human body.


ENVIRONMENTAL STUDIES
THERMAL RESPONSE ON ENTERING AND LEAVING HOT ENVIRONMENTS
COOPERATIVE USE OF PHYSIOLOGIC AND ENGINEERING TECHNIQUES
DEMONSTRATION OF
PHYSIOLOGICAL ADJUSTMENTS

Scenes from .

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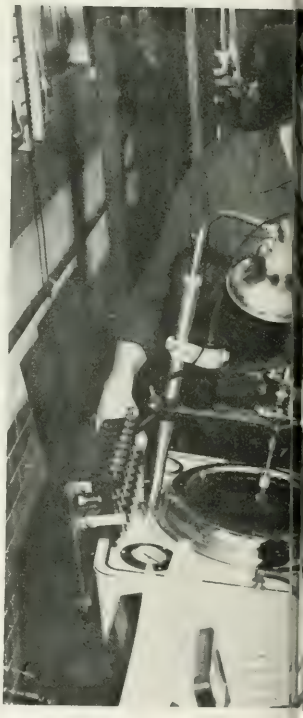

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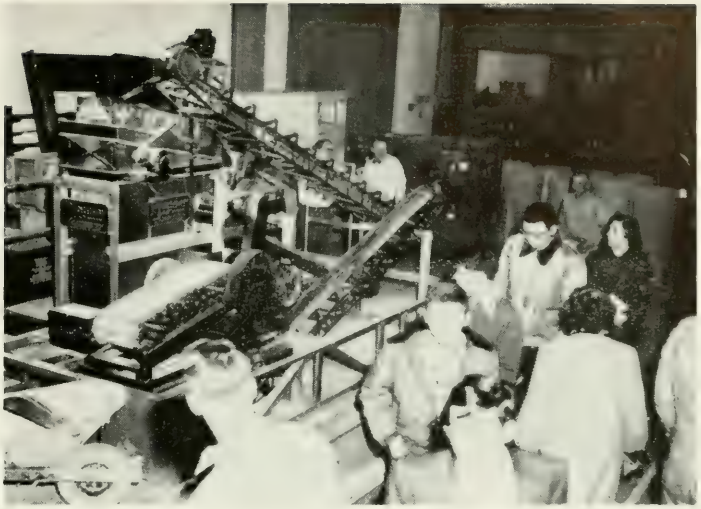

Above: Visitors view a model rock crushing plant set up in the materials testing laboratory. Below: The sport car on display in the Internal Combustion laboratory of the M. E. Department was one of the many attractions of the Engineering Open House.

MORE AIRCRAFT ENGINES
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Wherever you go in the aircraft world, you'll find this emblem—the acknowledged symbol of dependability. It's carried by big bombers, medium bombers, light bombers—by all types of commercial transports—by flashing jet fighters. In a field where only the best is good enough, it stands for outstanding engineering achievement. If you would like to work for the company with a future—in an industry with an unlimited future—set your sights on Pratt & Whitney Aircraft.

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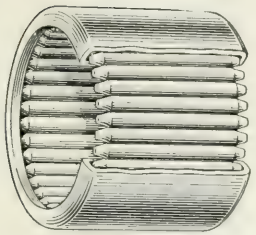
The Torrington Needle Bearing

. . . shaft hardness determines effective load capacity



The economy of the Torrington Needle Bearing is due in part to the fact that the shaft usually serves as the inner race. Thus, since the shaft is an integral part of the bearing, its load capacity limits the capacity of the bearing assembly. In order to obtain the full rated load capacity of the Needle Bearing, it is necessary that the shaft be at least surface-hardened to the equivalent of Rockwell C-58.

Loads and Speeds Related to Shaft Hardness

Because of material or design limitations, it is sometimes desired to run Needle Bearings on shafts softer than the recommended Rockwell C-58. This can be done safely providing the bearing loads and speeds are not too severe. However, the capacity of the bearing assembly is only as great as the load capacity of the shaft, regardless of the rated load capacity of the bearing as indicated in the catalog. The shaft capacity decreases very rapidly as the surface hardness is reduced below the recommended Rockwell C-58 minimum hardness.

Figure 1 shows this very clearly. It can be seen that reducing the shaft hardness to Rockwell C-52 gives a resulting load factor of .5. In this case, the catalog rating must be multiplied by .5 in order to obtain the true capacity of the bearing assembly.

Unheat-treated, cold rolled shafting will only carry 2%-3% of the bearing's rated load capacity.

The speed of the application is also important in determining proper hardness to assure satisfactory shaft life. The chart in Figure 2 illustrates this effect.

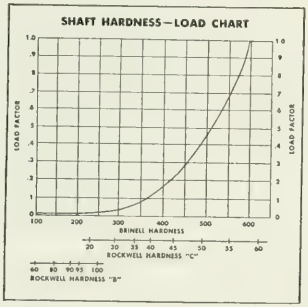


Figure 1. If the surface hardness of the shaft, its tensile strength, or the per cent of carbon is known, the load factor can be read either right or left from the intersection of the curve. The load factor, multiplied by the rated capacity of the bearing, will give the shaft capacity and the capacity of the application.

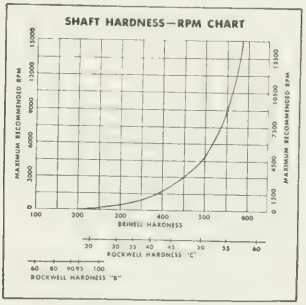


Figure 2. As the speed increases, it is desirable to increase the shaft hardness. For a given rpm, read across to the curve and down to the proper hardness. Conversely, if hardness is known, read up to the curve and across to the maximum rpm for that shaft.

Hardened Inner Races Available

When it is either impossible or impractical to harden the shaft, it is necessary to use an inner race which will provide the required surface for Needle Bearing operation. Inner races are available for all sizes of Needle Bearings. When used, inner races should be securely fastened to the shaft by clamping against a shoulder, by snap ring, or by press fit.

When designing Needle Bearings into a piece of equipment where shaft hardness is a question, the economics of using inner races as compared to a properly heat treated shaft should be carefully analyzed. When all factors such as inner race cost, securing devices, and actual assembly time are considered, it is usually found more economical to heat treat the shaft.

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Flying Ahead with . . .

Aeronautical Engineering

by Maurice Garnholz, Aero. E., '56

Since the organization of the Aeronautical Engineering Department at the University of Illinois in 1944, research has formed an integral part in the activities of both the students and the staff. Most of the staff members divide their time between teaching classes and delving into research in their respective specialties. Many papers written by several members of the staff have been published widely, both here and abroad.

A special problems course and chances to be employed as a computer or draftsman on a major research project are the two major opportunities for research open to the undergraduate. Graduate students with satisfactory qualifications may receive appointments as research assistants or associates, and all graduate students are required to conduct some independent research and submit a thesis.

A research project labeled as the Supersonic Propeller Problem was begun in June, 1947, and finished in March, 1949. Directed by Professor H. S. Stillwell, head of the Department, and completed through the efforts of four staff members, the object of the investigation was the development of a mathematical method for the design and analysis of propellers operating above the speed of sound.

Dr. T. P. Torda accepted a contract from Aerojet Engineering Corporation in 1950. Entitled "Boundary Layer Control by Continuous Surface Suction or Injection," the object of the analysis was to investigate the possibility of stall-prevention and achievement of high lift airfoils.

At the present time the department is involved in research in several specific areas. Dr. Harry H. Hilton, in one area of research, is concerned with photoelastic equipment. The design of a transonic wind tunnel is handled largely by Lloyd Gross, with Professor Stillwell in charge of the whole project. Lowell Eldrenkamp and Jim Xerikos, working under Professor T. P. Torda, have charge of research in mixing processes, done in connection with the Bentonite Channel. Dr. Fletcher handles research with the shock tube. Fred Hall, whose work is also supervised by Professor Torda, is conducting investigations of a compressor. Mr. P. Born, Research Associate, is also working on the same project. Professor McCloy is dealing with research in the field of propulsion.

Unlike several of the aforementioned projects, which are purely theoretical and mathematical, that dealing with the transonic-supersonic wind tunnel, conducted by Lloyd Gross, has tangible portions. Although much of it is still on paper, a tunnel is being built at the University of Illinois Airport. The test section, where a model will be placed, is to be 4″ x 6″. The complete apparatus will be 15½′ long, with the widest part being only 32″. Two Allison V-17 twin-jet engines, driving centrifugal compressors, will pump air through the tunnel at a rate of 10^{1}_{2} pounds mass per second.

In scientific circles, for purposes of simplification, the speed of sound is designated as Mach number 1. Hence, a speed of 0 miles per hour is Mach 0. As an object approaches the speed of sound the Mach number approaches 1. When the speed of sound is passed the Mach number becomes greater than 1, e.g., Mach 1.5 would indicate a speed 1½ times as great as the speed of sound, or about 1140 m.p.h. (760 x 1.5). at a temperature of 10°C.

It is possible to build a wind tunnel with as high a Mach number as is desired. Wind velocities in the wind tunnel at Aero Lab A start from rest and go to 150 m.p.h. Used as a student instruction tunnel, it is used to verify the theory of subsonic aerodynamics. A sufficiently large wind tunnel can get the air up to a speed of Mach .85 easily, but at higher speeds the shock wave which forms bounces off the wall and hits the model a second time, which causes unwanted additional interference. Enormous amounts of air can be pushed through until the speed of sound (Mach 1) is reached. After Mach 1 a strange phenomenon occurs. When the air is expanded (allowed to proceed into a larger section of the tunnel) the velocity *increases!* And similarly as the tunnel becomes smaller the air travels slower. This occurence is just the opposite of what happens at subsonic speeds.

Even with this occuring, it is still easy to put air through at a speed of Mach 1. But just as soon as something (usually a model) is put in the tunnel, immediate trouble arises. The shock waves formed on the object (particularly the wing) bounce off the walls back to the wing, setting up double shock waves.

Gross and his assistants believe that they have a solution to the problem. They intend to draw the air off through holes to prevent this "choking." Since the bouncing shock waves of air bounce off the wing and out they cannot reinterfere with following shockwaves. But first the research workers intend to run tests to see which type of holes will be best for this work.

Tunnels have been built in other sections of the country which can handle air with speeds up to Mach .9, while other, larger tunnels have been built handling air with speeds above Mach 1.3. The University wind tunnel is intended for research on air speeds from Mach. 9 to Mach 1.3. It is as Lloyd Gross says, "That little gap needs to be bridged," before information about the supersonic can be considered complete.

As in almost any field of research and experiment, one small, unforeseen thing may alter things greatly.

It is expected that the wind tunnel will be finished about the 15th of April.

There are two ways to go about solving any problem—direct and indirect. In the case of the blade for a compressor, the direct method would entail the

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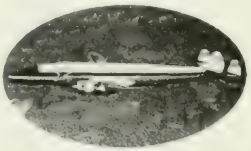

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specifying of the blade shape, then the solving for the flow around it. The blades interfere with the flow though, and hence it is practically impossible to solve this problem directly. It is just this type of research that is being done by Fred Hall.

In the indirect method, one would specify the velocity components and solve for the blade shape that would be best. With this method one doesn't have to compute the flow effects. The department is, consequently, using the indirect method in the analysis of a compressor, which is not yet built and probably won't be built unless the equations turn up something great, for this is one of the research projects which is all paper work and theory. All analytical work now, this paper research is intended to lead to an optimum in pressure design.

To acquire an ideal blade a mathematical analysis is necessary. The results of this analysis will be used in the design of compressors, which will be used in jet engines, cooling, and electronics. The results would also apply to turbines, for a turbine is essentially a compressor in reverse.

Research delving into the flow of streams past a flat thin plate, two plates, or even a tube is being carried on by Lowell Eldrenkamp and Jim Xerikos. "Theoretical Studies of the Mixing Process of a Jet Impinging into a Stream of Large Mass" is the imposing title of this project. It is a comprehensive study of the things that happen in the wake.

Located in the basement of the Mechanical Engineering Building is a piece of equipment used in connection with this phase of research carried on by the Aeronautical Department. This piece is known as the Bentonite Channel, and the method used in experimental work is the "Photo-Viscous Method for Analyzing Fluid Flow." This method uses polarized light for visualizing certain areas in a field of moving liquid, which is a colloidial suspension of bentonite clay in water. This solution flows through a tube about 15 feet long with cross-sectional dimensions of approximately 1" x 6". When the suspension flows, a pattern appears around the model due to double refraction induced in the suspension by the presence of velocity gradients in the flow. This pattern is composed of fringes of various colors. These fringes represent different amounts of double refraction in the fluid, which in turn represent different values of the velocity gradients.

This method is applied to qualitative studies of laminar and turbulent conditions in the wake of the flat plate. All aerodynamics is built around a flat plate. From a flat plate it progresses to a curved plate and finally to a curved plate with thickness (a wing).

In the Bentonite Channel a flat plate is held in a plastic rectangular tube. Plastic material is used because of its transparency. Also the bentonite clay has properties that corrodes ferrous metals.

In previous investigations, the velocity distribution of the mixing streams has been assumed as uniform at the start of mixing, and, thus, the influence of the existing boundary layers along the separating plate has been neglected. It is believed that the results show, for the first time, the influence of the upstream boundary layers on the mixing process.

The width of mixing regions and the velocity distribution in it has been evaluated by the von Kármán integral concept as applied to the momentum and energy equations.

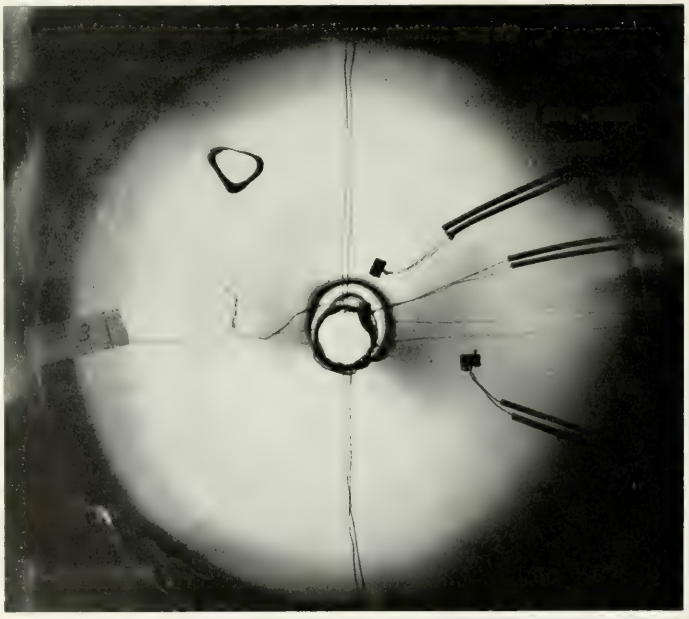
The University of Illinois is the first place where any work has been done on mixing processes around a plate, taking into account the fact that the velocity distribution isn't uniform due to the boundary layer.

There are several theoretical problems involving the behavior of shock waves when they are reflected from walls and other obstacles which have not yet been satisfactorily solved. These are fundamental problems in the behavior of shock waves and are best studied experimentally. The problem of the behavior of shock waves is a basic one in the aerodynamics of compressible fluids.

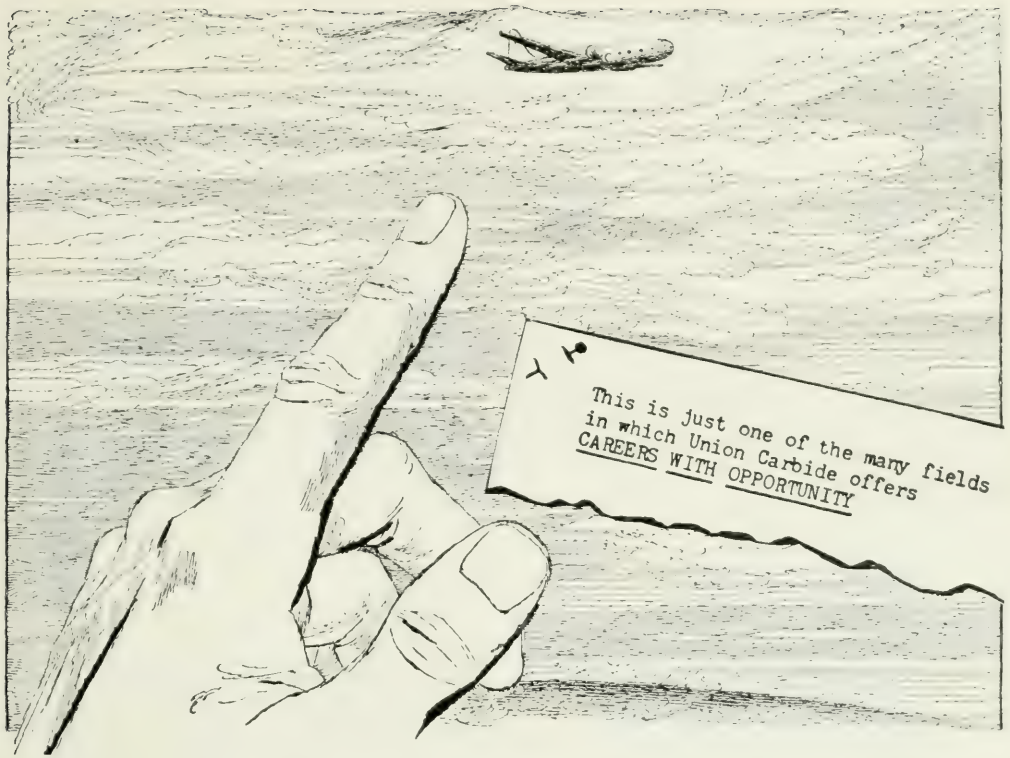
The instrument used to carry on this type of research is the shock tube, located in Aero Lab B and operated under the direction of Dr. Fletcher. It has a cross section of 4" x 15" and is 36 feet long. The shock tube permits the study of air flow and pressure about a body at supersonic speeds.

At the same time a shock wave is generated, a flow of air is generated behind it. This flow has a speed which depends upon the strength of the shock wave and can be controlled from Mach number 0 to Mach 1.7. This includes the so-called transonic range, in which conventional wind tunnels are difficult to use. Wind of transonic speed is used so that investigation can be made either of the behavior of the shock or of the flow which follows it when a model is placed in the tube.

A shock wave is generated in the U of I shock tube by first putting a diaphragm of plastic—sometimes paper—in a special place near the beginning of the tube. A pressure of 600 lbs. sq. in. is applied by eight cylinders, each 2" in diameter. Diaphragms, usually made from cellulose acetate, with a thickness of 3, 5, 7, 10, or 15 thousandths of an inch are used. The diaphragm is clamped in and is compressed



Thermal stresses showing around the hole of a plastic body which is being heated by electricity. The three large wires are thermal couples.



Things are different—up there!

You would be amazed at the tricks nature plays in the stratosphere

As aviation progress has carried man farther into the upper air, he has found that nature has many tricks up her sleeve in the stratosphere. Many things that worked well on the ground wouldn't do as well, or failed completely, in the space beyond the clouds. Things are truly different up there.

CARBON BRUSHES ARE AN EXAMPLE—These brushes are the contact points that carry electricity between moving and stationary parts of motors and generators. They're in electric razors, sewing machines, huge diesel locomotives—and in modern aircraft.

THEY COULDN'T STAND ALTITUDE—Today's high-flying planes require literally hundreds of small electric motors and many carbon brushes. Here was one of nature's quirks, for brushes which worked well on the ground and at lower altitudes couldn't take the thin, dry air of the stratosphere. They'd spark and quickly disintegrate. And if the brushes failed, the motors also would fail.

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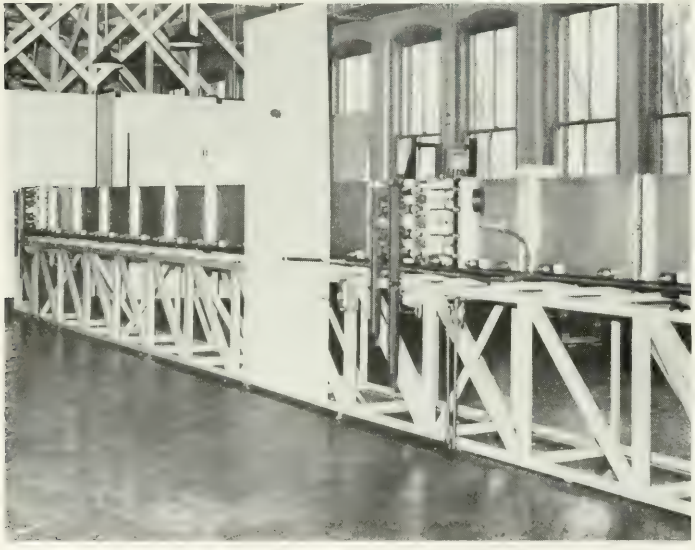
in the high pressure side (shorter end). Then the diaphragm is broken with compressed air or punctured with a needle made for this purpose. This compressed gas escapes down the tube, pushing low pressure gas ahead of it and generating shock waves *in* the *low pressure* gas.

As the air is compressed at transonic or supersonic speed, the compressed portion becomes very hot, and the expanded gas behind the shock wave becomes colder. In certain shock tubes elsewhere the temperature becomes as hot as 10,000 degrees. In the Illinois tube the temperature reaches about 600°F.

The tube can also be evacuated—down to a pressure of 1/1000 of an atmosphere (one atmosphere equals 14.7 lbs. / sq. in.), if needed—to simulate lower pressures, such as those found at high altitudes, where most of our modern high-speed planes fly. Evacuation is usually done when a very strong shock is desired to be obtained, for strength of shock waves depends upon the *ratio* of absolute pressures on the two sides of the diaphragm. While the breaking strength of the diaphragm depends upon the *difference* of pressure between the two, in order to obtain a high ratio with a small pressure difference, a low absolute pressure in the low pressure chamber is required. Hence, a partial vacuum is used.

The velocities of the shock waves vary from slightly greater than that of sound, about 1150 feet/second, to about 4000 feet second in *this* shock tube. These velocities may be measured by allowing the shock waves to pass through a narrow light beam. When they do this they cause a deflection of the beam, which may be detected by a photo-cell and knife-edge combination. Two light beams are usually used, separated by about a foot, and the time interval which elapses between the interceptions between these two beams may be measured on a coronograph. The coronograph which is under construction will permit an accuracy of about ½ microsecond (one microsecond is one-millionth of a second) in the determination of this interval.

Since the shock wave travels with the speeds mentioned above, ordinary mechanical instruments do not permit or give reliable measurements. The flow which follows the shock wave lasts for only a few thousandths of a second, and mechanical gauges do not respond rapidly enough to be used here. These difficulties are dealt with by using optical methods of measurement. These optical methods require a high intensity source of light and a very short exposure time to detect the rapid changes which occur. The usual technique is to use a spark, which lasts about a microsecond, and which provides sufficient light for satisfactory photographic exposures. The photographs are usually taken through an interferometer which gives an indications of the density of the gas. When it is intended only to detect the shock waves themselves, a shadowgraph technique may be used.



The shock tube of Aero Lab "B", in which velocities up to 1.7 times the speed of sound are obtained. (Photos courtesy Aero Engineering Department)

Professor H. H. Hilton is undertaking a research project purely on his own time. What he is trying to do is observe thermal stresses in a body which is being heated. He takes plastic, heats it, and looks at it through polarizers, which show the stresses in varied colors and shades. He is attempting to observe the "creep" of the material in relation to time. More specifically, a circular plastic plate with a hole in the middle is heated by a resistance wire. This project is experimental and under no contract.

Closely connected to his own project, but sponsored by the Air Force, is the contracted research project directed by Professor Hilton. The official title of it is "Thermal Stresses and Viscoelastic Bodies." This research is all theoretical. At high temperatures a body gets what is known as "creep" and stress relaxation. In certain ranges of temperature, the stresses fall off. The fact that material properties are all functions of temperature is the basis of most of the theoretical work in the project. Thus there is a double problem —that of creep *and* that of temperature variation.

The practical applications of the results of this research will be connected with high speed aircraft, aerodynamic heating of the wings or outer skin, deicing, power plant, jets, and rockets.

Research in the field of propulsion is being done at the University of Illinois Airport by Professor McCloy, who is assisted by Dick Smutney. The first design model of a valveless pulse-jet and also the latest in the series, both of which have been conceived and designed by Professor McCloy, were on display at the Engineering Open House March 27-28, 1953. This ram-jet was a major attraction, due largely to the tremendous noise it made while in operation. Professor McCloy is presently under contract to the United States Navy for the development of a modified ram-jet engine. This project is classified; hence, little more can be freely said about it.

Customer: Your dog seems very fond of watching you cut hair.

Barber: It ain't that; sometimes I snip off a bit of a customer's ear.

* * *

Elderly Lady (visiting prison): I'm sure, my poor man, that poverty brought you into this.

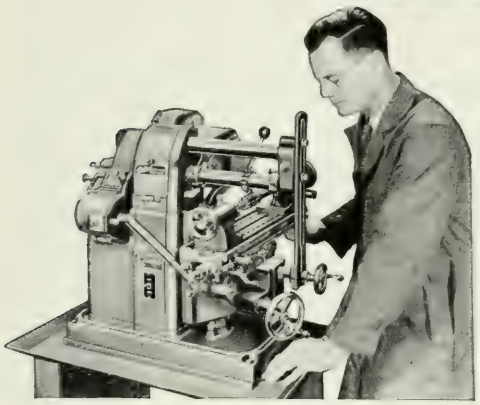
Prisoner: No, madam, I was coining money.

* * *

Customer: Your wife is really a good worker.

Grocer: She sure is. Wish I had a couple more like her.

Another page for **YOUR BEARING NOTEBOOK**



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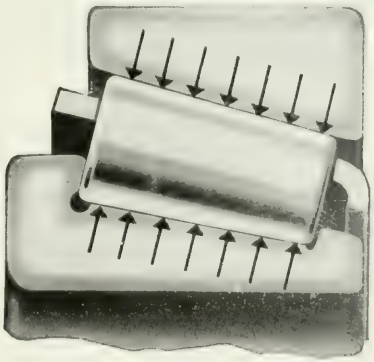

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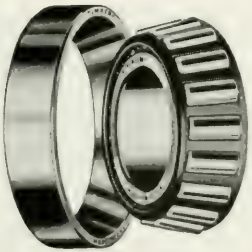

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Navy Pier . . .

CHICAGO GOES UNDER

by Don Schilke, Comm., '56, and Jerry Wheeler, C.E., '56

Doctors tell us we're suffering from a new disease. It is strictly a 20th century development. It has an insidious nature. The results can lead to physical violence or mental breakdown. Its name traffic neurosis.

Chicago loop businesses fear a by-product of this disease. When shoppers become fed up with loop parking facilities, rates, and traffic, they will take their patronage elsewhere. Loop business suffers.

Chicago has constructed new superhighways, arterial streets and boulevards. This modernization of Chicago's traffic system will increase the traffic volume in and around the central business district. Off-street parking is therefore a paramount necessity.

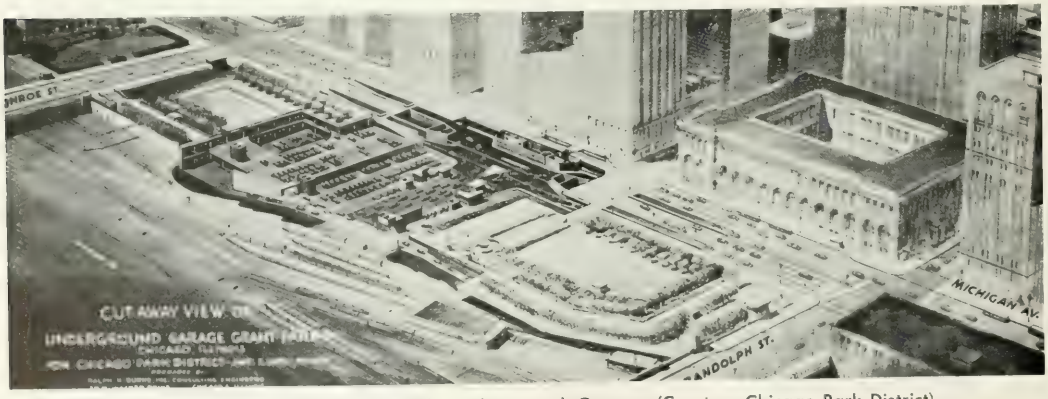
Many proposals have been advanced in recent years to construct an underground garage beneath Grant Park along Michigan Avenue. Time studies and field checks reveal that the adjacent Lake Shore Drive is the most heavily traveled street in the City of Chicago. Twenty-seven percent of the downtown population work within five minutes walking distance of the parking site. Recognized as the most heavily concentrated shopping center of the nation, convenient to hotels, theaters, and office buildings, this garage site possesses advantages unparalleled by any other location in Chicago.

Although private investors have offered to build and operate the new parking project, the Chicago Park District has undertaken its entire development and operation. The estimated $8,300,000 cost was financed by revenue bonds. Because of existing legislation, which prevented any construction from marring the beauty of Grant Park, an amendment to the Chicago Park District Act was passed, which allows the construction of underground parking facilities.

In December, 1952, Ralph H. Burke, Inc., consulting engineers for the project, received 50 bids from various construction companies. Contractors who requested specifications and drawings received more than 1,000 square feet of blueprints. The bid was awarded to the John Griffith & Sons Construction Co. Included in the contract was a $500 a day bonus/penalty clause.

The initial work began in February, 1953, when a landscape contractor removed 131 elm trees from the surveyed area, and the park's statues, balustrades and fountains were placed in storage. Upon completion of the project in November of next year, four feet of soil will cover the portion of the garage under Grant Park, and the landscape will be restored to its former beauty.

Before major earth moving operations could begin, Michigan Avenue traffic



Cutaway view of the Grant Park Underground Garage. (Courtesy Chicago Park District)

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• In the laboratories of today, the world of tomorrow is taking shape—test by test, experiment by experiment.

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More than a quarter of a century ago Standard Oil opened its first automotive laboratory, and from time to time has enlarged the facilities.

Now Standard Oil has added still another unit. The new building located at Whiting, Indiana, is devoted entirely to the testing and development of automotive fuels and lubricants.

Full-scale testing is conducted in a room containing every needed facility for the measurement and control of operating conditions. The test engines include the principal types used today or anticipated for the future. Each of 16 engines, with its dynamometer, is mounted on a separate concrete foundation, isolated from other parts of the building to eliminate vibration.

In the expansion of our laboratories, young technical men find evidence that the challenge of the future, with its stimulation and rewards, is being met at Standard Oil.

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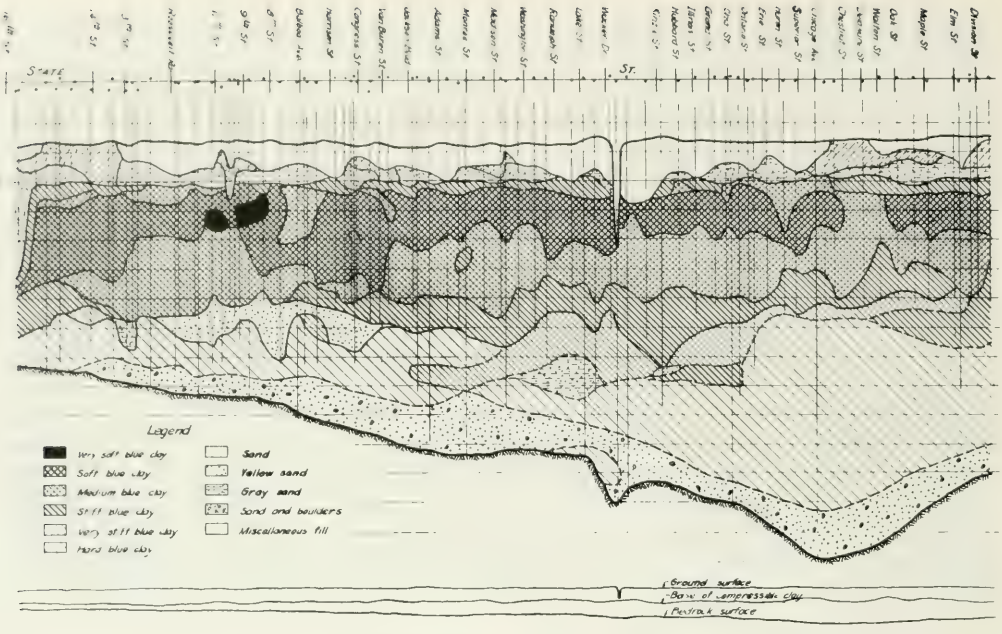

DETAILED PROFILE ALONG STATE STREET

was re-routed over a temporary road thru the easterly half of Grant Park. A 24-inch water main, a 20-inch gas main, a 7-foot sewer, fire and police alarm systems, and electric power facilities were gathered up from under Michigan Avenue and moved to the west curb.

The underground garage will consist of three parts: the mezzanine, which will hold 130 cars, the main floor, 1,037 cars, and the lower level, 1,192 cars, totaling a 2,359 capacity.

Ramps on Michigan Avenue will provide two entrances and two exits. As the motorist enters the garage, he will have a choice of self-parking or letting an attendant handle it. The rates for attendant parking will be slightly higher. After entering the desired lane, each driver will be given a stamped ticket which records the date, time and last four digits of the license number.

Stalls which are occupied will have red ceiling lights. Orange lights will indicate attendant parking areas. Green ceiling lights will call attention to empty parking spaces.

After parking his car, the motorist will walk to the west side of the garage where he may take an escalator up to Michigan Avenue at either Washington Boulevard, Randolph or Monroe Street, thus eliminating the need of crossing Michigan Avenue at grade level.

A great deal of consideration has been given to that old American nemesis —speed. Because the supporting columns are spaced 29′ apart, the motorist will be blessed with 9′ by 18′ parking stalls. This large area will facilitate easier and faster parking.

The cashier booths will be located at the north, south and central sections, there-by shortening walking distances for self-parkers and attendants. The use of computers, totalizers and an inter-communication system will expedite all operations.

The cost of parking in the underground garage will be less than that of the average parking lot in the northeast section of the loop, especially if the motorist chooses to park his car without the help of an attendant. The average attendant parking rate in Chicago is 65c for one hour and $1.25 for nine hours, with self-parking rates at 45c and $1.10.

Cost of construction is estimated at $8,300,000 or $3,515 per stall. It is estimated that the total yearly revenue will gross $1,230,750 with a $545,500 net.

Walls, columns and floors will be constructed of reinforced concrete. The waiting room, rest rooms and locker rooms will be heated by a low pressure steam system and finished in glazed tile glass set in aluminum. The ramps and receiving lanes will have radiant heating for automatic snow removal. Walls and fire doors will divide the garage into fire protection areas, and fire alarm temperature rise detectors are to be installed throughout.

The safety and comfort of motorists has been given every consideration. Ventilation is to be mechanical with a maximum change of air every 3.6 minutes. The intensity and arrangement of ramp lighting is planned to effect a minimum contrast between sunlight and underground illumination.

The worst thing about getting old is to have to listen to a lot of advice from one's children.

—*Lake Mills Graphic*

* * *

Eskimo's Wife: You look terrible this morning, dear!

Eskimo: I'm a nervous wreck. Those darn dogs must've barked two months last night.

DOW

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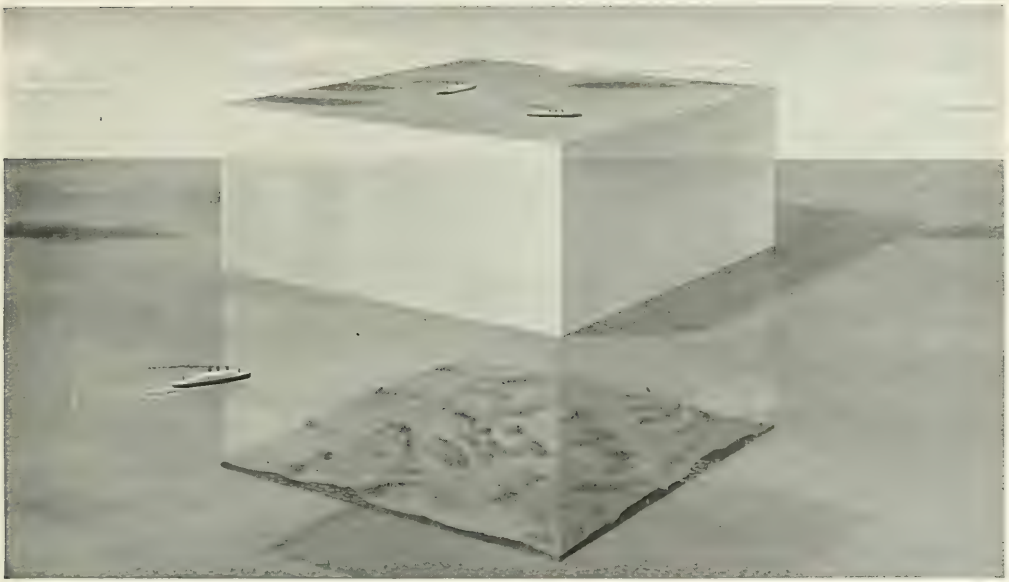

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DOW

3-D

by Eric Aagaard, M.E., '53

The science of photography has made enormous advances since its early days when it took ten minutes to expose a photographic plate in bright sunlight. Today we have photographs and motion pictures which quite accurately reproduce scenes as they might actually appear as to lights and shades, perspective, color, definition, and movement. These pictures are nearly perfect in all but one very important respect — they do not reproduce a scene in its original solidity and relief. When we can produce a photographic reproduction which gives the effect of looking through a window at the original scene instead of seeing a flat sheet of paper or movie screen, we will have come much closer to producing a perfect picture; one which is indistinguishable from the original.

The science dealing with the seeing of objects in three dimensions is known as stereoscopy. Men have been speculating as to the causes of this phenomenon since the time of Euclid, who mentioned it in his writings in 280 B. C. Numerous conjectures were advanced after this time, but all the early explanations were extremely vague. It was not until the early part of the sixteenth century from a manuscript left by the famed Florentine painter, scientist, and engineer, Leonardo da Vinci, that the first definite theory of binocular vision was known; the explanation universally accepted today.

The stereoscopic effect in seeing is primarily due to the fact that each human eye sees a slightly different view of a scene from its mate. This may be demonstrated by a simple experiment. Hold a fairly thin book with its back toward you about ten inches in front of your face. When your left eye only is closed, you should see the back and right side of the book. When the left eye is opened and the right eye is closed, you will see the left side and back, but not the right side.

If a small sphere were substituted for the book, each eye would see almost one-half of its total surface. Together the eyes would see more than one-half the total surface, since each eye has a slightly different view of the sphere. This seeing around an object is interpreted by the brain, which fuses the images from the eyes, as a sensation of depth and solidity.

A factor in vision which tends to make some objects appear more distant than others is known as convergence. This is the angle formed between the rays of light entering each eye from the same point on an object. When an observer is looking at an object about ten inches from his face this angle is about fifteen degrees; when the object is at a very great distance the angle is very nearly zero. It is evident that convergence angle varies in an inverse relation with object distance.

Since the region of most acute sight is the center of the field of vision, the eye is equipped with muscles which turn the eye ball to bring the object viewed to the center of the field. Since the center of the visual field of each eye would now correspond to a side of the angle of convergence with the object, the eyes must turn inward when looking at the object.

Convergence may be demonstrated by the following experiment. About a foot before your face hold one forefinger vertical. While holding the attention of your eyes on the finger observe objects beyond it. These further objects will appear greatly blurred since the eyes are trained on only the angle of convergence substended by the finger. If the eyes are now trained on objects beyond the finger, the finger will apparently split into two. Again this may be explained by the dissimilar angles of convergence.

Accomodation is another factor which plays a role in stereoscopic vision, although not as important a one as those factors mentioned above. Accomodation refers to the ability of the eye to focus the image formed by the lens onto the retina. This situation is analogous to the focusing of a camera and is not dependent upon the use of both eyes. Some people, particularly older ones, who do not possess the full power of accomodation may remedy this defect with bifocal glasses.

There are other factors which influence our sense of stereoscopic vision. When we close one eye we still sense more depth and solidness than could be attributed to accomodation alone. Strictly speaking this sensation could not be called stereoscopic vision at all, since it is due to our knowledge of existing conditions. We know the effects of perspective, light and shade, atmosphere, the size of certain objects, and the like. It would be difficult to determine the size and relative distances of irregularly shaped objects placed against a black background and viewed with one eye only.

We may perform another simple experiment. Place a coin on a table so it projects partly over the edge. Close one

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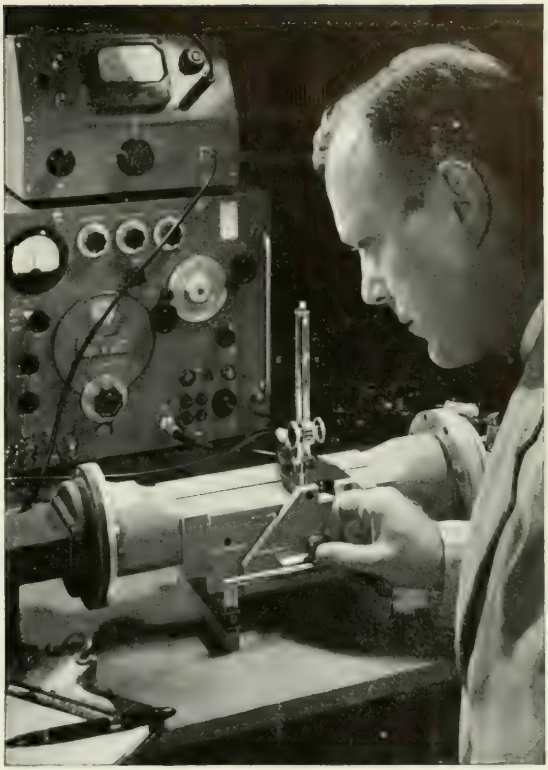

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eye, walk a step or two away from the table, turn around, walk up to the table, and without hesitation knock the coin from the table with your forefinger. You will probably fail nine times out of ten, although you should have no trouble if you repeat this experiment with both eyes open. It follows that true stereoscopic vision is possible only when we use both eyes. The psychological reactions involved in fusing and interpreting the images from the two eyes are complex and not well understood. It is not the purpose of this article to discuss these reactions but rather to show what physical conditions are necessary to produce stereoscopic effects artificially.

It should be mentioned that some people do not possess the faculty of stereoscopic vision. The reason may be these people depend almost entirely upon one dominant eye for vision, or they may have one eye which is considerably weaker than the other.

The Stereo Viewer

As mentioned earlier each of the human eyes sees a slightly different view of an object. If a reproduction of the proper view can be presented to each eye the major condition for stereoscopic vision is satisfied. When mounted side by side the reproductions may be viewed without artifical aid with a little training on the part of the observer. These stereograms, as they are often called, first took the form of drawings long before the dawn of photography. The earliest known examples of these drawings were made by the Neapolitan, Giovanni Battista della Porta (1538—1615), who is often credited with the invention of the camera obscura and the magic lantern. There are difficulties which arise when stereograms are viewed directly. The eyes have trouble fusing the two reproduced views, since the required angle of convergence is less than normally required at the actual viewing distance. This unnatural condition causes eyestrain and some distortion of the picture. Since the eyes cannot readily diverge, the distance between the centers of the individual views cannot be greater than the distance between the eyes. This limits the width of the individual views to about two and one-half inches, therefore requiring the views to be held unnaturally close if any details is to be seen.

Eliot's stereoscope, a viewing device which partially eliminated these difficulties, was introduced in the third decade of the last century. It consisted of an oblong rectangular box with two peep holes for the eyes in one end and a single hole in the center of the opposite end. To view a stereogram with this device it was necessary that the lines of sight cross, that is, the left eye saw only the right view of the stereogram while the right eye saw only the left view. The views were, of course, mounted in the reverse of their natural order. There was no restriction on the size of the views. The instrument could be used by most people despite the unnatural angle of convergence.

The first completely practical stereoscope was introduced by the scientist, Sir Charles Wheatstone, in 1883. The two views of the stereogram were separated and placed face to face in parallel planes on either side of the observer's head. The observer saw reflected images of the views through two mirrors, one placed before each eye. The views could be as large as desired and placed at any convenient distance from the observer. The natural angles of convergence could be obtained. Since mirrors were used the stereo views had to be reversed reproductions, that is, reproduced writing on the views read from right to left rather than from left to right. In an improved version of the Wheatstone stereoscope, which is used for aerial survey work today, a second pair of mirrors was introduced to allow the use of normal unreversed stereograms. The inherent bulk of this instrument was its principle disadvantage.

In 1849 the Scot, Sir David Brewster, described a compact stereoscope in which the views were mounted side by side. Between each view and the eye was placed a thin prism which displaced the image toward the center of the field of vision, thus producing natural convergence. In latter models the prisms were replaced by prismatic lenses which enlarged the images as well as providing convergence. Prismatic lenses are half sections of simple convex lenses. The famous parlor stereoscope common to the homes of our grandparents was of the Brewster type. These popular instruments ranged from cheap mail order house productions to expensive models mounted in cabinets inlayed with semiprecious stones. The views were mostly inexpensive halftone reproductions on $3\frac{1}{4} \times 6\frac{1}{4}$ inch cardboard mounts. The introduction of other entertainment mediums, such as motion pictures, were chief causes of the parlor stereoscope's downfall. We should not lament its loss, because its often poor construction produced eyestrain and the cheap halftone reproductions used in the stereograms left much to be desired from a technical standpoint. However, before we leave the parlor stereoscope to its grave, it should be mentioned that Oliver Wendell Holmes invented the popular form of this instrument.

It should be evident that magnifying lenses before the eyes permit the use of stereographic views of small size, the only restriction being that the views provide adequate definition of fine detail. When the individual views are two and one-half inches wide or less, the centers of the views may be placed on the axis of the eyes, thus allowing the use of full convex lenses in the place of prismatic lenses. The optician Hermagis constructed an instrument of this type in 1856, followed by the German scientist, Helmholz, in 1866. Well made instruments of this type produce the finest stereo effects presently obtainable. The use of well ground achromatic lenses eliminate the eyestrain associated with the prismatic lenses of the Brewster stereoscope. Practically all modern instruments are of this type and are usually equipped with focusing devices, interocular distance adjustments, and built-in sources of illumination.

The beautiful stereograms obtainable from the use of modern full-color photographic films have been largely responsible for the present great popular interest in three dimensional photography. Before a further discussion of viewing is made, it will be well to mention the technique of producing photographic stereograms.

Making the Stereo Photograph

The two views of the stereogram may be made with an ordinary still camera which is moved the interocular distance between exposures. Suitable brackets are available at photographic supply houses to give this restricted movement to a camera mounted atop an ordinary tripod. Since two separate exposures must be made, this system is not suitable for photographs of moving objects. Stereograms are made most conveniently with a twin-lens camera; essentially the optical systems of two cameras mounted in the same body. Since the lens and shutter adjustments of such cameras are tied together, the twin-lens camera is no more difficult to operate than an ordinary single-lens camera. Several excellent twin-lens stero cameras designed to use 35 mm. color film are available to the amateur or professional photographer.

A simple device available to the photographer allows the use of any single lens camera for making one exposure stereograms. It is a small box about three inches long containing a train of prisms (or mirrors depending upon the quality of the device). The stereo images are transmitted from two openings in one side of the box by prisms to a single opening in the back of the device which fits over the lens of a conventional camera. The two stereo images are formed on the film area normally occupied by a single image. The device is also available for small movie cameras.

THE DU PONT DIGEST

DU PONT SCIENCE AND ENGINEERING GRADUATES MEET THE PUBLIC IN

Technical Sales

More and more, industry is on the lookout for technically trained men and science majors who have an interest in and aptitude for selling. A number of departments at Du Pont prefer men with such training for sales positions. A technical understanding of the properties of a substance helps a man do a better selling job—and offers the customer better service.

Because of the diverse applications of Du Pont's many products, there is a need for sales representatives with widely varying technical backgrounds. There are problems involving chemistry and many types of engineering in such fields as plastics, ceramics, textiles and many others.

Technical men may work in direct sales, sales service, or sales development groups, depending on departmental organization. In some cases technical men handle all phases of selling. In others they deal mainly with customer problems. Some departments also maintain a sales development section that works on technical problems connected with the introduction of a new product or a new application for an established one.

Edgar G. Boyce, *Ashland State (right), helps a customer improve his method of applying silicate adhesive in the manufacture of corrugated boxboard.*

Ivan R. Smith, *B.S. in Ch.E., Kansas State University '40 (right), advises the operator of a galvanizing machine on the efficient use of a Du Pont flux.*

Here are examples of the kind of problems attacked by technical men in Du Pont sales groups:

1. Find a more economical way to apply sodium silicate used in making corrugated paperboard. Du Pont men, as in many other instances, were able to make substantial savings for the customer.

2. Introduce fabrics of "Orlon" acrylic fiber for use in dust filtration. This involved evaluation and modification of filter fabrics in cooperation with makers of dust-control equipment, and with plant personnel having serious dust-recovery problems.

3. Reduce the time needed for processing motion-picture film used by race tracks. Technical service men carried the problem to a research group which developed an emulsion that could be processed in about one-third the former time.

James A. Newman, *B. S. in Ch. E., North Carolina State '40, discusses study of optimum settings and conditions for carding nylon staple with Prof. J. F. Bogdan of North Carolina State's Research Division.*

Technical men interested in sales work at Du Pont usually acquire needed background in a laboratory or manufacturing plant. Depending on their interest and abilities, they may then move into technical sales service, sales development, or direct sales.

In any of these fields, the man with the right combination of sales ability and technical knowledge will find not only interesting work but exceptional opportunities for growth in the Company.

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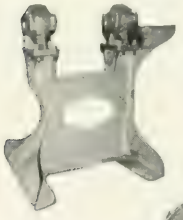
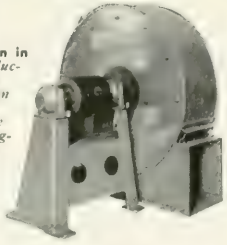
The examples show how a typical machine part was changed over from cast iron to welded steel construction. The cost saving of 50% resulted from less material and expense by eliminating several machining operations such as milling and drilling. Cleaning and painting operations in the former cast design were also avoided. The new welded steel base is both stronger, more rigid and has a clean streamlined appearance to improve selling appeal.

Latest information on designing structures to save steel and lower cost is presented in 1200 page "Procedure Handbook of Arc Welding Design and Practice". Price only $2.00 postpaid in U.S.A.



Original Cast Construction *required 41% more material. Heavier weight increased handling costs in manufacture, shipment and installation.*



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Group Viewing

To this point the discussion has been limited to viewing devices used by only one individual. The recent interest in three dimensional photography demonstrated the desirability of audience viewing of stereograms. Of the many group viewing methods proposed, the presently most practical and commonly used was developed in 1936 by Edwin H. Land for projected still slides and motion pictures. The method involves mounting two projectors side by side, each projector presenting one of the views of the stereo pair. A polarizing filter, that is, a material which transmits light vibrating in one plane only, is mounted in each projector. The two images projected on the screen are polarized at right angles to one another.

Polarized light will pass through a polarizing filter only when the plane of polarization of the filter is nearly the plane of polarization of the transmitted light. In the Land system the spectators are provided with spectacles containing polarizing filters arranged at right angles so that each eye sees only one of the projected stereo images. Amateur equipment of this type for projecting movies and slides is available on the open market. The three dimension films presently being produced and distributed by the motion picture industry use the polarizing system.

Stereoscopic motion pictures should not be confused with motion picture systems involving the use of a curved screen, such as the Cinerama. These latter systems depend upon the wide screen to give the spectator the sense of being among the actors on the screen; they do not produce true stereoscopic effects.

It is entirely possible to produce stereograms requiring no viewing device or special adaptation by the spectator. Store window displays often use the line screen stereo system. The original exposure is made with an ordinary single lens camera. A screen, made of fine vertical lines ruled on a glass plate, is placed in contact with the photosensitive face of the film within the camera. The spaces between the ruled lines are equal to the width of the lines. After one exposure is made, the screen is shifted the width of a ruled line, the camera is moved laterally the interocular distance, and the second exposure is made on the previously unexposed portions of the original negative. Thus the processed photograph will contain both views of the stereo pair in alternate vertical strips.

Viewing is accomplished with the aid of another vertically ruled screen placed a fraction of an inch before the photograph. When properly placed, this screen will allow each of the spectator's eyes to see only the portions of the photograph showing the proper stereo view. Since proper viewing conditions are dependent upon the position of the spectator with respect to the screen and the photograph, the line screen stereo system does not give entirely satisfactory results.

A potentially more perfect system involves the use of a lenticular film. The lens of the camera used must be extremely wide, perhaps on the order of eight or more inches. The photosensitive coating is on the side of the film away from the lens, thus the transparent base of the film is between the lens and the photosensitive coating. The uncoated surface of the film base is a series of cylindrical lenses forming a corrugated pattern. Each cylindrical lens, together with the strip of photosensitive material immediately behind it, is in itself a miniature camera. After the single exposure is made, the film is given reversal type processing, that is, the positive photographic image is produced on the original film. The film, when illuminated from behind, now produces stereoscopic effects to the unaided eye. An interesting feature is the spectator's ability to look behind objects in the three dimensional picture, that is, the spectator may, by moving his head, see objects in the picture originally obstructed by other objects in the foreground.

The practical applications of stereoscopy are by no means limited to pictorial photography. Stereoscopy finds wide applications in topography, microscopy, radiography, and astronomy.

For many years the center of pictoral stereoscopic photography has been Europe. However, since the Second World War precision stereoscopic equipment has been produced in large quantities in this country and a revived interest in stereoscopy is developing. Three dimensional photography is gaining a position of prominence in our lives.

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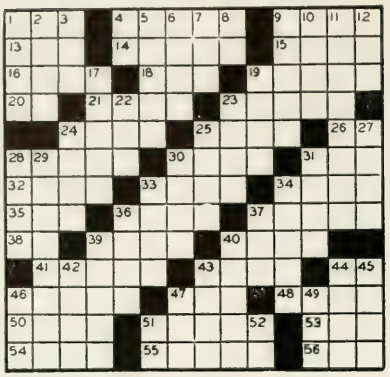

ACROSS

1. Important part of a hydro-electric plant
4. Sharp
9. Seth's grandfather: Bible
13. Metric surface unit
14. Synthetic rubber
15. Molten rock
16. Marshes
18. A distilled spirit
19. Surgical bristle
20. Silvery metal: chem. symbol
21. The one over there
23. Block to keep a wheel from turning
24. Bench
25. Gash
26. Indefinite one
28. Exclamation of impatient contempt
30. Associate of Felix Savart in 1820
31. Bustle
32. Small particle
33. Flash of lightning
34. Thick part of clabber
35. Billiard stick
36. Stronghold
37. Light boat
38. Sound of hesitation
39. Stratagem
40. A pursuit
41. Developed an electric telegraph in 1834
43. Near me
44. Parent
46. Taut
47. Electrically charged particle
48. Developed an all-glass light bulb in 1879
50. Custom
51. Decorate
53. Improve with time
54. Individuals
55. Greek sylvan deity
56. Fresh

DOWN

1. Built an electric locomotive in 1883
2. Tract
3. Enlisted soldiers
4. Hebrew month
5. First violinist to broadcast on the radio
6. One
7. Color produced by sunlamps
8. Plural suffix
9. Watchful
10. Facts
11. Italian physicist defined the molecule in 1811
12. Aided William Sawyer develop an electric lamp in 1875
17. Often used in electric generating plants
19. Impale
22. Turn to the left
23. Opening for insertion of coins
24. Sliding contact resting on a third-rail
25. Sediment
27. Point at rest in a vibrating wire
28. Step
29. English physicist, made an electro-magnet in 1825
30. Afflict with ennui
31. Relative
33. Employer: colloq.
34. Walking sticks
36. Protection against overloads in a circuit
37. Mongrel
39. Corrodes, as iron
40. Constructed the first electro-magnetic motor in 1829
42. English queen daughter of James II
43. Derisive shout
44. Invented a "galvanic multiplier" in 1837
45. All over again
46. Pair
47. Mrs. Eddie Cantor
49. Pallid
51. Like
52. City "45 minutes from Broadway" initials

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New society . . .

General Engineering Society

by Bob Nieman, Gen. E., '55

This spring the administration of the Curriculum of General Engineering was transferred from the Dean's office to the Department of General Engineering Drawing and the name of the department was then changed to General Engineering. While some members of the former Drawing Department handled the details of registration and advising of the General Engineering students, the department is now charged with complete responsibility for this curriculum.

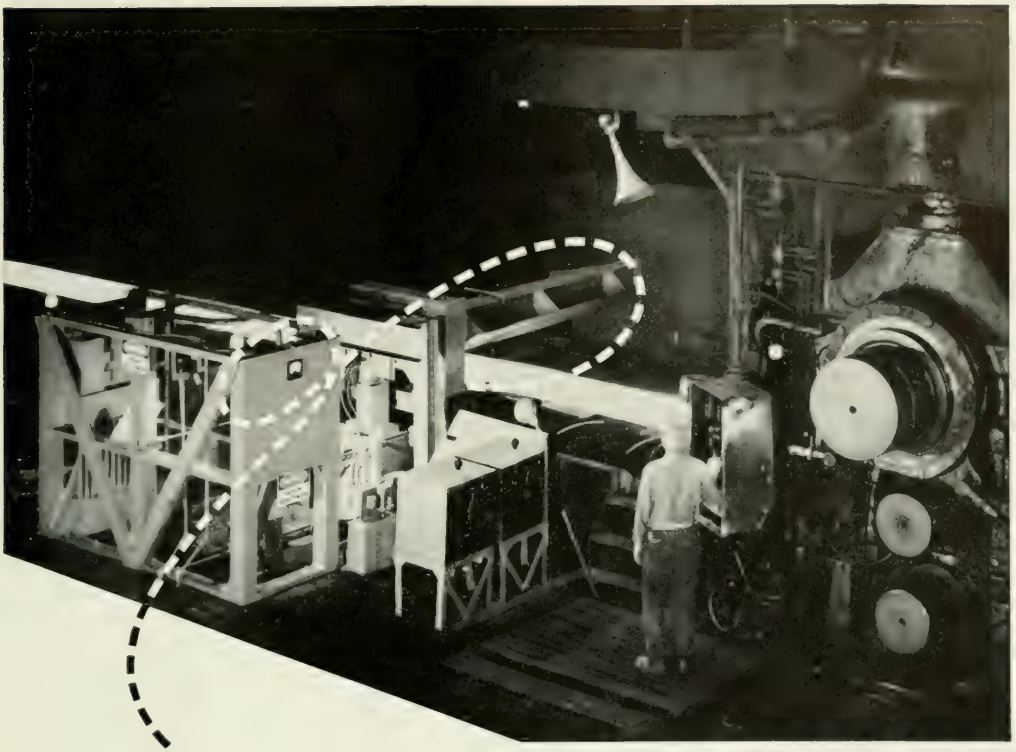
The General Engineering curriculum provides the student with the sound fundamental core of an engineering education. Its chief appeal lies in the fact that it permits the student to specialize in areas of training not readily available in other curricula. The basic core permits the choice of electives which are useful for a career in engineering business or salesmanship, technical journalism, or teaching. A proper selection of electives may further provide the ground work for employment in engineering research or geology.

Upon formation of the new Department of General Engineering both the students and faculty expressed interest in a society for General Engineers. Heretofore the General Engineering students were not represented as a group and existed more or less independently with no definite ties on campus.

Interest was translated to action when the Student-Faculty Relations Committee of the Department of General Engineering called a meeting for all General E.'s with the purpose in mind of reestablishing the Illinois Society of General Engineers. The General Engineers had at one time their own society but it was disbanded due to the war.

The enthusiasm expressed at the first meeting was encouraging to all concerned. Consequently plans were laid for the coming semester and officers were elected as follows: President, Bill Getzen; Vice-president, Jack Kiest; Secretary, Bob Neiman; Treasurer, Dick Somerville.

Beginning next fall, the Society will attempt to further the interests of the General E. student in campus affairs. To acquaint the students with their fellow students and the faculty, to keep the members informed of current affairs in industry and to promote greater interest in the profession will be among the objectives of the society.



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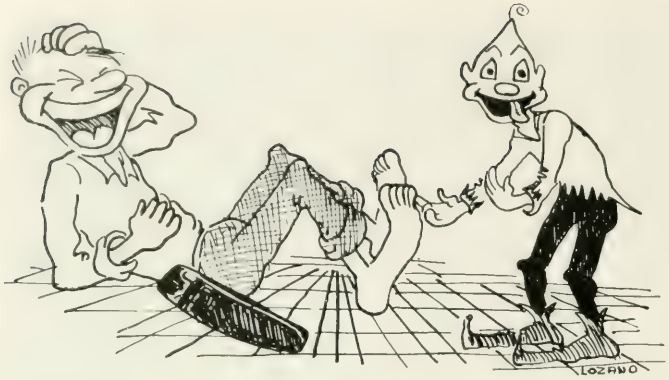

TECHNOCRACKS

"I've got a job at last, Dad," the young actor reported. "It's a new play and I take the part of a man who has been married twenty years."

"Splendid," said the father. "That's a start anyway, my boy. Maybe one of these days they'll give you a speaking part."

* * *

Al: I was supposed to make my stage entrance after the baboons.

Pal: Why didn't you?

Al: They might have thought it was an encore.

* * *

A young actor had made good in Hollywood to a certain extent. On a trip to his home town, the younger element of the town planned a great celebration in his honor.

"Please," the young actor said modestly to the celebration ring leaders, "let's not have undue fuss. Treat me the same as you would Bob Hope."

* * *

"Two hundred dollars for an electric refrigerator? That's too much," said the prospective buyer and walked out of the store.

The next morning he ordered a refrigerator over the phone, and requested immediate delivery.

"Might I ask what made you change your mind?" asked the salesman.

"Certainly," replied the customer. "When I came home yesterday my wife was leaning over our old icebox and I gave her a playful pat. Without looking up, she said, "Fifteen pounds today, darling."

* * *

He kissed her in the garden,
It was a moonlight night,
She was a marble statue,
He was a little tight.

That modernistic furniture confuses me. The other night I was visiting a friend who had nothing but modernistic furniture in his apartment. I couldn't tell a chair from a table until I asked him where an ash tray was and he said I'd been sitting in it for the past half hour.

* * *

The young widow was attending a seance and after the usual routine the spiritualist announced that he had a message from her departed husband to send him a package of cigarettes.

"Where shall I send them?" she asked. "He didn't give an address."

"Well," solemnly replied the spiritualist, "you notice he didn't ask for any matches."

A man was introduced to a circus sword swallower. Not having seen a sword-swallower before, he asked him to demonstrate his art, whereupon the fellow apparently swallowed some pins and needles.

"But," protested the man, "those are not swords—they're pins and needles."

"I know," was the reply, "I'm on a diet."

* * *

A sparrow built a nest on an electric line pole and the hillbilly climbed up to see if the eggs had hatched. The higher he got the more frantic the mother bird became, swooping, swirling and chattering angrily.

A moment later he touched the live wire and was knocked to the ground unconscious. As he opened his eyes and saw the still angry bird, he sadly shook his head. "What a wallop," he muttered, for such a little bird."

* * *

A near-sighted man lost his hat in a strong wind. He ran after it, but every time he was about to catch up with it, it was whisked away from under his hand. After ten minutes he was exhausted.

Then a woman screamed at him from a nearby farmhouse.

"What do you think you're doing?"

The man explained that he was merely trying to recover his hat.

"Your hat!" exclaimed the woman. "It's over there by the wall—you've been running the legs off my little black hen!"

* * *

"Johnson is so conceited."

"Yes, on his last birthday he sent a telegram of congratulations to his mother!"

"AND THEN MY FATHER SAID — FAH TO THESE GEIGER COUNTERS, I KNOW RADIO-ACTIVITY WHEN I SEE IT!"

PHOTOGRAPHY AT WORK No. 2 in a series:

Knitting mill solves help shortage, attracts and keeps full staff

Hand Knit Hosiery Company of Sheboygan, Wisc., knitters of Wigwam Socks, found many potential employees resisted jobs simply because they didn't know the sort of opportunities offered.

To explain job opportunities, to enlist an efficient staff, here's how this company used photography

Like most businesses today, the knitters of Wigwam Socks found the getting and keeping of good people on jobs a major problem. Especially since some of the work had names strange to highly desirable personnel—such as looping, box drying, etc.

But Hand Knit's industrial relations director knew the potency of photography—used it to show applicants *what* their work would be, what they wear, what their boss looked like. From then on an efficient factory force was more easily lined up—and *kept*. Any business profits when cameras and film get to work.

There are so many new uses for photography being found, that many well-qualified graduates in the physical sciences and in engineering have been led to find positions with the Eastman Kodak Company.

If you are interested, write to Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

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The training programs summarized here are only a few of the "open doorways" that lead to successful careers in a company where big and important jobs are being done, and where young people of vision and courage are needed to help do them.

If you are interested in building a G-E career after graduation, talk with your placement officer and the G-E representative when he visits your campus. Meanwhile, for further information write to College Editor, Dept., 2-123, General Electric Co., Schenectady 5, New York.

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